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THE

BRITISH ENCYCLOPEDIA,

OR

DICTIONARY

OF

ARTS AND SCIENCES;

COMPRISING

AN ACCURATE AND POPULAR VIEW

OF THE PRESENT

IMPROVED STATE OF HUMAN KNOWLEDGE.

BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

ILLUSTRATED WITH

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BY

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ELLIPSIS.

ELLIPSIS, in geometry, a curve line returning into itself, and produced from the section of a cone by a plane cutting both its sides, but not parallel to the base. See CONIC SECTIONS.

The easiest way of describing this curve, in plano, when the transverse and conjuaxes A B, E D, (Plate V. Miscell. fig. 1.) are given, is this: first take the points F, *f*, in the transverse axis A B, so that the distances C F, C *f*, from the centre C, be each equal to $\sqrt{AC - CD}$; or, that the lines F D, *f* D, be each equal to A C; then, having fixed two pins in the points F, *f*, which are called the foci of the ellipsis, take a thread equal in length to the transverse axis A B; and fastening its two ends, one to the pin F, and the other to *f*, with another pin M stretch the thread tight; then if this pin M be moved round till it returns to the place from whence it first set out, keeping the thread always extended so as to form the triangle F M *f*, it will describe an ellipsis, whose axes are A B, D E.

The greater axis, A B, passing through the two foci F *f*, is called the transverse axis; and the lesser one D E, is called the conjugate, or second axis: these two always bisect each other at right angles, and the centre of the ellipsis is the point C, where they intersect. Any right line passing through the centre, and terminated by the curve of the ellipsis on each side, is called a diameter; and two diameters, which naturally bisect all the parallels to each other, bounded by the ellipsis, are called conjugate diameters. Any right line, not passing through the centre, but terminated by the ellipsis, and bisected by a diameter, is called the ordinate, or ordinate-applicate to that diameter; and a third proportional to two conjugate diameters, is called the latus rectum, or parameter of that diameter which is the first of the three proportionals.

The reason of the name is this: let B A, E D, be any two conjugate diameters of an ellipsis (fig. 2, where they are the two axes) at the end A, of the diameter A B, raise the perpendicular A F, equal to the latus rectum, or parameter, being a third proportional to A B, E D, and draw the right line B F; then if any point P be taken in B A, and an ordinate P M be drawn, cutting B F in N, the rectangle under the absciss A P, and the line P N will be equal to the square of the ordinate P M. Hence drawing N O parallel to A B, it appears that this rectangle, or the square of the ordinate, is less than that under the absciss A P, and the parameter A F, by the rectangle under A P and O F, or N O and O F; on account of which deficiency, Apollonius first gave this curve the name of an ellipsis, from ελλειπειν, to be deficient.

In every ellipsis, as A E B D, (fig. 2), the squares of the semi-ordinates M P, *m p*, are as the rectangles under the segments of the transverse axis A P × P B, A *p* × *p* B, made by these ordinates respectively; which holds equally true of the circle, where the squares of the ordinates are equal to such rectangles, as being mean proportionals between the segments of the diameter. In the same manner, the ordinates to any diameter whatever, are as the rectangles under the segments of that diameter.

As to the other principal properties of

the ellipsis, they may be reduced to the following propositions. 1. If from any point M in an ellipsis, two right lines, M F, M f, (fig. 1.) be drawn to the foci F, f, the sum of these two lines will be equal to the transverse axis A B. This is evident from the manner of describing an ellipsis. 2. The square of half the lesser axis is equal to the rectangle under the segments of the greater axis, contained between the foci and its vertices; that is, $DC^2 = AF \times FB = Af \times fB$. 3. Every diameter is bisected in the centre C. 4. The transverse axis is the greatest, and the conjugate axis the least, of all diameters. 5. Two diameters, one of which is parallel to the tangent in the vertex of the other, are conjugate diameters; and *vice versa*, a right line drawn through the vertex of any diameter parallel to its conjugate diameter, touches the ellipsis in that vertex. 6. If four tangents be drawn through the vertices of two conjugate diameters, the parallelogram contained under them will be equal to the parallelogram contained under tangents drawn through the vertices of any other two conjugate diameters. 7. If a right line, touching an ellipsis, meet two conjugate diameters produced, the rectangle under the segments of the tangent, between the point of contact and these diameters, will be equal to the square of the semi-diameter, which is conjugate to that passing through the point of contact. 8. In every ellipsis, the sum of the squares of any two conjugate diameters is equal to the sum of the squares of the two axes. 9. In every ellipsis, the angles F G I, f G H, (fig. 1), made by the tangent H I, and the lines F G, f G, drawn from the foci to the point of contact, are equal to each other. 10. The area of an ellipsis is to the area of a circumscribed circle, as the lesser axis is to the greater, and *vice versa* with respect to an inscribed circle; so that it is a mean proportional between two circles, having the transverse and conjugate axes for their diameters. This holds equally true of all the other corresponding parts belonging to an ellipsis.

The curve of any ellipsis may be obtained by the following series. Suppose the semi-transverse axis $CB = r$, the semi-conjugate axis $CD = c$, and the semi-ordinate $= a$; then the length of the curve $MB = a + \frac{r^2 a^3}{6 c^4} + \frac{4 r^2 c^2 a^5 - r a^5}{40 c^8} + \frac{8 c^4 r^2 a^7 + r^6 a^7 - 4 c^2 r^5 a^7}{112 c^{12}}$, &c. And, if the species of the ellipsis be determined, this series will be more simple: for if $c = 2r$, then $MB = a + \frac{a^3}{96 r^2} + \frac{3 a^5}{2048 r^4} + \frac{113 a^7}{458752 a^6} + \frac{3419 a^9}{75497472 r^8}$, &c. This series will serve for an hyperbola, by making the even parts of all the terms affirmative, and the third, fifth, seventh, &c. terms negative.

The periphery of an ellipsis, according to Mr. Simpson, is to that of a circle, whose diameter is equal to the transverse axis of the ellipsis, as $1 - \frac{d}{2.2} - \frac{3 d^2}{2.2.4.4} - \frac{3.3.5 d^3}{2.2.4.4.6.6} - \frac{2.3.5.5.7 d^4}{2.2.4.4.6.6.8.8}$, &c. is to 1, where d is equal to the difference of the squares of the axis applied to the square of the transverse axis.

Ellipsis, in grammar, a figure of syntax, wherein one or more words are not expressed; and from this deficiency it has got the name ellipsis.

Ellipsis, in rhetoric, a figure nearly allied to preterition, when the orator, through transport of passion, passes over many things: which, had he been cool, ought to have been mentioned. In preterition, the omission is designed; which, in the ellipsis, is owing to the vehemence of the speaker's passion, and his tongue not being able to keep pace with the emotion of his mind.

ELLIPTIC, or Elliptical, something belonging to an ellipsis. Thus we meet with elliptical compasses, elliptic conoid, elliptic space, elliptic stairs, &c. The elliptic space is the area contained within the curve of the ellipsis, which is to that of a circle described on the transverse axis, as the conjugate diameter is to the transverse axis; or it is a mean proportional between two circles, described on the conjugate and transverse axis.

ELLIPTOIDES, in geometry, a name used by some to denote infinite ellipses, defined by the equation $ay^{m+n} = bx^m (a-x)^n$.

Of these there are several sorts: thus, if $ay^3 = bx^2 (a-x)$ it is a cubical elliptoid; and if $ay^4 = bx^2 (a-x)^2$, it denotes a biquadratic elliptoid, which is an ellipsis of the third order in respect of the apollonian ellipsis.

ELLISIA, in botany, so called in memory of John Ellis, F. R. S. a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Borragineæ, Jussieu. Essential character: corolla fun-

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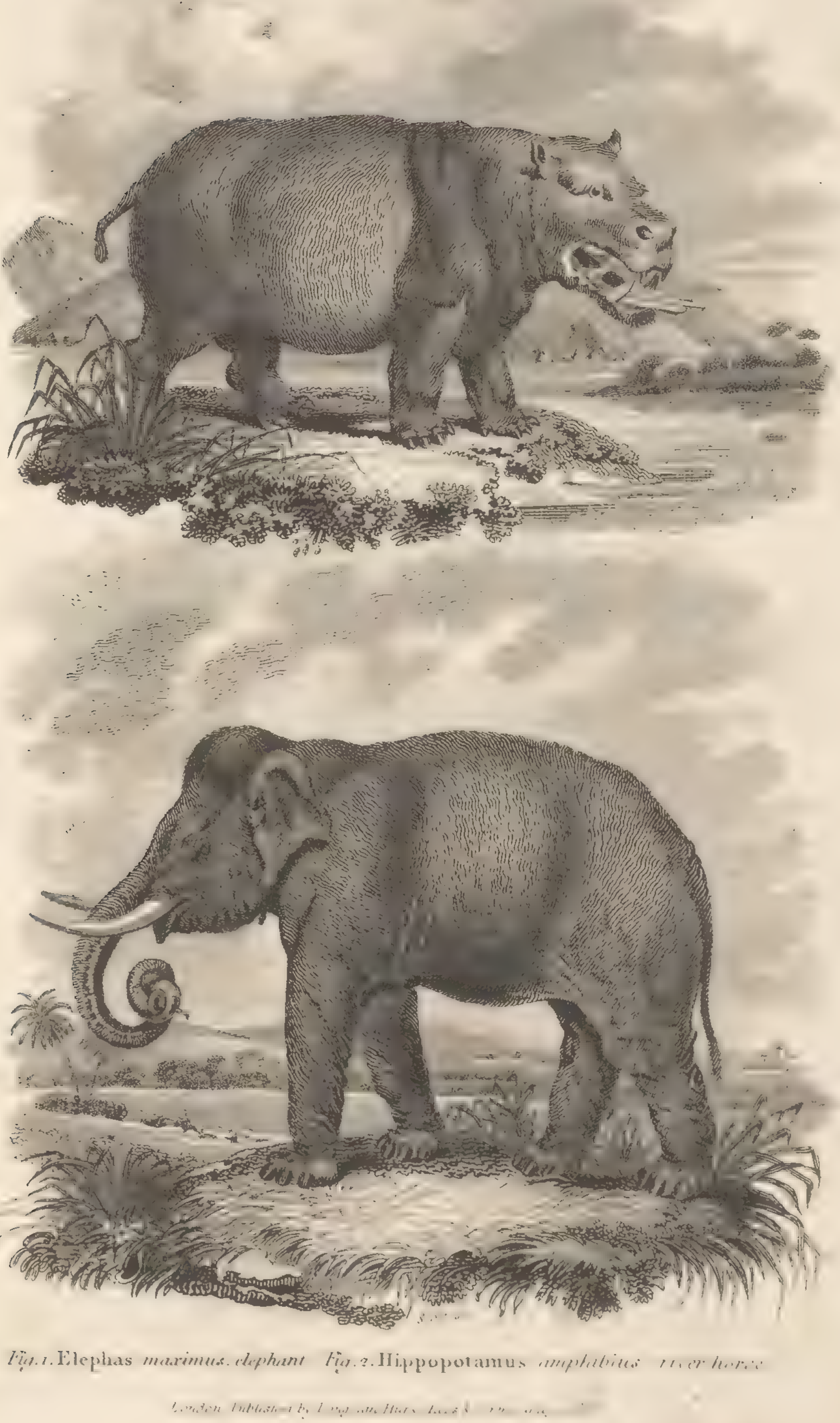

Fig. 1. Elephas *maximus. elephant* *Fig. 2.* Hippopotamus *amphibius river horse*

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nel-form, narrow; berry dry, two-celled, two-valved; seeds two, dotted, one placed over the other. There is only one species, *viz.* E. nyctelea, cut-leaved ellisia, a native of Virginia.

ELM. See Ulmus. The elm is very serviceable in places where it may lie continually dry, or wet in extremes. Accordingly, it is proper for water-works, mills, the ladles and soles of the wheel-pipes, pumps, aqueducts, pales, and ship-planks beneath the water-lines. It is also of use for wheelwrights, handles for single saws, axle-trees, and the like. The clearness of the grain makes it also fit for all kinds of carved works, and most ornaments relating to architecture.

ELOCUTION, in rhetoric, the adapting words and sentences to the things or sentiments to be expressed. It consists of elegance, composition, and dignity. The first, comprehending the purity and perspicuity of a language, is the foundation of elocution. The second ranges the words in proper order; and the last adds the ornaments of tropes and figures to give strength and dignity to the whole.

ELOGY, a praise or panegyric bestowed on any person or thing, in consideration of its merit. The beauty of elogy consists in an expressive brevity. Elogiums should not have so much as one epithet properly so called, nor two words synonimous. They should strictly adhere to truth; for extravagant and improbable elogies rather lessen the character of the person or thing they would extol.

ELONGATION, in astronomy, the digression or recess of a planet from the sun, with respect to an eye placed on our earth. The term is chiefly used in speaking of Venus and Mercury, the arch of a great circle intercepted between either of these planets and the Sun, being called the elongation of that planet from the Sun.

But here it is to be observed, that it is only a circle which has the sun for its centre; that the greatest elongation is in a line touching the planet's orbit. For in an elliptic orbit it may be, that the elongation from the sun may grow still greater, even after it has left the place where the line joining the earth and planet touches the orbit. For after that, the true distance of the planet from the Sun may increase, whilst the distance of the Sun and planet from the Earth does not increase, but rather decrease. But, because the orbits of the planets are nearly circular, such small differences may be neglected in astronomy. The greatest elongation of Venus is found by observation to be about forty-eight degrees, and the greatest elongation of Mercury about twenty-eight degrees, upon which account this planet is rarely to be seen with the naked eye.

Elongation, *angle of*, is an angle contained under lines drawn from the centre of the sun and planet to the centre of the earth.

ELOPEMENT, is, when a married woman of her own accord departs from her husband, and dwells with an adulterer; for which, without voluntary reconciliation to the husband, she shall lose her dower by the statute of Westminster, 2. c. 34. Except that her husband willingly, and without coercion of the church, reconcile her, and suffer her to dwell with him, in which case, she shall be restored to her action. 13 Ed. I. st. 1, c. 34. By eloping in this manner, or living in adultery apart from the husband, he is discharged of her future debts, and no longer liable to support her.

ELOQUENCE, the art of speaking well, so as to affect and persuade. Cicero defines it, the art of speaking with copiousness and embellishment. Eloquence and rhetoric differ from each other, as the theory from the practice; rhetoric being the art which describes the rules of eloquence, and eloquence that art which uses them to advantage. See Rhetoric.

ELOPS, in natural history, a genus of fishes of the order Abdominales. Generic character: head smooth, edges of the jaws and palate rough, with teeth; gill membrane with thirty rays, and armed on the outside in the middle with five teeth. The saury elops, the only species, bears a considerable resemblance to a salmon, from which it differs principally in wanting the fleshy back fin. It inhabits the shores of Carolina and the West Indies; in Jamaica it passes by the name of the sun-fish. It is in general about fourteen inches long.

ELYMUS, in botany, *lymegrass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, or Grasses. Essential character: calyx lateral, two-valved, aggregate, many-flowered. There are eleven species.

EMARGINATED, among botanists, an appellation given to such leaves as have a little indenting on their summits: when this indenting is terminated on each side by obtuse points, they are said to be obtusely

emarginated; whereas when these points are acute, they are called acutely emarginated.

EMBALMING, is the opening a dead body, taking out the intestines, and filling the place with odoriferous and desiccative drugs and spices, to prevent its putrefying. The Egyptians excelled all other nations in the art of preserving bodies from corruption, for some that they have embalmed upwards of 2000 years ago, remain whole to this day, and are often brought into other countries as great curiosities. Their manner of embalming was thus: they scooped the brains with an iron scoop out at the nostrils, and threw in medicaments to fill up the vacuum: they also took out the entrails, and having filled the body with myrrh, cassia, and other spices, except frankincense, proper to dry up the humours, they pickled it in nitre, where it lay soaking for seventy days. The body was then wrapped up in bandages of fine linen and gums, to make it stick like glue; and so was delivered to the kindred of the deceased, entire in all its features, the very hairs of the eyelids being preserved. They used to keep the bodies of their ancestors, thus embalmed, in little houses magnificently adorned, and took great pleasure in beholding them alive, as it were, without any change in their size, features, or complexion. The Egyptians also embalmed birds, &c. The prices for embalming were different; the highest was a talent, the next 20 minæ, and so decreasing to a very small matter; but those who had not wherewithal to answer this expence, contented themselves with infusing, by means of a syringe, through the fundament, a certain liquor extracted from the cedar; and leaving it there, wrapped up the body in salt of nitre: the oil thus preyed upon the intestines, so that when they took it out, the intestines came away with it, dried, and not in the least putrified: the body being inclosed in nitre, grew dry, and nothing remained besides the skin glued upon the bones.

The method of embalming used by the modern Egyptians, according to Maillet, is to wash the body several times with rose-water, which he elsewhere observes, s more fragrant in that country than with us. They afterwards perfume it with incense, aloes, and a quantity of other odours, of which they are by no means sparing; and then they bury the body in a winding-sheet, made partly of silk and partly of cotton, and moistened, as is supposed, with some sweet-scented water or liquid perfume, though Maillet uses only the term moistened; this they cover with another cloth of unmixed cotton, to which they add one of the richest suits of clothes of the deceased. The expence, he says, on these occasions, is very great, though nothing like what the genuine embalming cost in former times.

EMBARGO, in commerce, an arrest on ships, or merchandize, by public authority; or a prohibition of state, commonly on foreign ships, in time of war, to prevent their going out of port; sometimes to prevent their coming in; and sometimes both for a limited time. The King may lay embargoes on ships, or employ those of his subjects, in time of danger, for service and defence of the nation; but they must not be for the private advantage of a particular trader, or company; and therefore a warrant to stay a single ship is no legal embargo. No inference can be made from embargoes which are only in war time; and are a prohibition by advice of council, and not at prosecution of parties. If goods be laden on board, and after an embargo, or restraint from the prince or state comes forth, and then the master of the ship breaks ground, or endeavours to sail, if any damage accrues, he must be responsible for the same: the reason is, because his freight is due, and must be paid, nay though the goods be seized as contraband. Embargo differs from quarantine, insomuch as this last is always for the term of forty days, in which persons from foreign parts infected with the plague are not permitted to come on shore. See QUARANTINE.

EMBASSADOR, or AMBASSADOR, a public minister sent from one sovereign prince, as a representative of his person, to another.

Embassadors are either ordinary or extraordinary. Embassador in ordinary is he who constantly resides in the court of another prince, to maintain a good understanding, and look to the interest of his master. Till about two hundred years ago, embassadors in ordinary were not heard of; all, till then, were embassadors extraordinary, that is, such as are sent on some particular occasion, and who retire as soon as the affair is dispatched.

By the law of nations, none under the quality of a sovereign prince can send or receive an embassador. At Athens, embassadors mounted the pulpit to the public orators, and there opened their commission,

acquainting the people with their errand. At Rome they were introduced to the Senate, and delivered their commissions to them.

Embassadors should never attend any public solemnities, as marriages, funerals, &c. unless their masters have some interest therein: nor must they go into mourning on any occasions of their own, because they represent the persons of their prince. By the civil law, the moveable goods of an embassador, which are accounted an accession to his person, cannot be seized on, neither as a pledge, nor for payment of a debt, nor by order or execution of judgment, nor by the King's or state's leave, where he resides, as some conceive; for all actions ought to be far from an embassador, as well that which toucheth his necessaries, as his person: if, therefore, he hath contracted any debt, he is to be called upon kindly, and if he refuses, then letters of request are to go to his master. Nor can any of the embassador's domestic servants, that are registered in the Secretaries of State's Office, be arrested in person or goods: if they are, the process shall be void, and the parties suing out and executing it shall suffer and be liable to such penalties and corporal punishment as the Lord Chancellor, or either of the chief justices, shall think fit to inflict. Yet embassadors cannot be defended when they commit any thing against that state, or the person of the prince with whom they reside; and if they are guilty of treason, felony, &c. or any other crime against the law of nations, they lose the privilege of an embassador, and may be subject to punishment as private aliens.

EMBER *weeks*, or *days*, in the Christian Church, are certain seasons of the year, set apart for the imploring God's blessing, by prayer and fasting, upon the ordinations performed in the church at such times. These ordination-fasts are observed four times in the year, *viz.* the Wednesday, Friday, and Saturday after the first Sunday in Lent, after Whit-sunday, after the fourteenth of September, and the thirteenth of December; it being enjoined, by a canon of the church, that deacons and ministers be ordained, or made, only upon the Sundays immediately following these ember-fasts. The ember-weeks were formerly observed in different churches with some variety, but were at last settled as they are now observed, by the council of Placentia, anno 1095. The council of Mentz, convened by Charlemagne, mentions the ember-weeks as a new establishment.

EMBERIZA, the *bunting*, in natural history, a genus of birds of the order Passeres. Generic character: bill conic; mandibles receding from each other, from the base downwards; the lower with the sides narrowed in; the upper containing a large knob of use to break hard seeds. There are, according to Gmelin, seventy-seven species. Latham enumerates sixty-three, of which the most important are the following: E. nivalis, the snow bunting. These birds are about the size of a chaffinch, and have been found in the most northern latitudes to which navigators have penetrated. They are found, not merely on the land about Spitzbergen, but upon the ice contiguous to it, though merely graminivorous birds, of which genus they are the sole species found in that climate. In the north of Great Britain they sometimes appear in vast flocks, and are considered as the harbingers of a severe winter. They are known in Scotland by the name of snow-flake. E. hortulana, the ortolan, is somewhat less than the yellow-hammer, is common in France and Italy, in Germany and Sweden. These birds are migratory, and in their passage, are caught in vast multitudes to be fed for the table, being considered as extremely delicate and luxurious food. They are inclosed by professional feeders in dark rooms, where oats, and other grains, and seeds are provided for them in the fullest abundance. On these articles they feed with such voracity, that in a short time they attain that size, which it is impossible for them to exceed, and constitute, it may almost be said, one mass of exquisitely flavoured and luscious fat. From this state they would soon sink in lethargy, but they are now killed by their owners for the market. A full-fed ortolan weighs about three ounces. It rarely passes farther north than Russia, and is not to be found in England. By many its notes are particularly admired. It sometimes builds on low hedges, and occasionally on the ground, and generally breeds twice a year. E. citrinella, or the yellow hammer, is extremely common in Great Britain, where it lays its eggs on the ground, or in some low bush, constructing it with little art; it possesses no interesting musical tones, and is tame and stupid in its character; it feeds on grain and insects, and is to be found in almost every country in Europe; its flesh here is generally bitter, but in Italy the

yellow hammer is fattened like the ortolan for the table, and is in considerable estimation. E. miliaria, the common bunting. These birds are also particularly common in England, and appear frequently in vast flocks, especially in the winter, during which they are caught in nets, or shot in vast numbers, and sold to many under the successful pretence of their being a species of larks. They are stationary in England, but on the Continent are birds of passage. During the incubation of the female, the male is observed frequently on the bare and prominent branch of some neighbouring tree, exerting himself to cheer her confinement by his song, which, however, is harsh and monotonous in the extreme; at short intervals he utters a sort of trembling shriek, several times repeated. E. oryzivora, or the rice bird, is peculiar to America, where its depredations on the rice and maize, subject it to the peculiar aversion of the farmer. These birds often mingle with birds of other species, as the red winged oriole, and the blue jay. They are, occasionally, kept for the sake of their music. In the autumn they return from Carolina farther south, for the winter; and it is observed, by Latham, that the males and females arrive at different times, the latter always appearing first. For the cirl bunting, see Aves, Plate VI. fig. 4. For the blackhead bunting, see Aves, Plate VI. fig. 5.

EMBEZZLEMENT, in law, by stat. 39 G. 3. c. 35. for protecting masters against embezzlements by their clerks and servants; servants or clerks, or persons employed for the purpose, or in the capacity of servants or clerks, who shall, by virtue of such employment receive, or take into their possession, any money, goods, bond, bill, note, banker's draft, or other valuable security or effects, for or in the name, or on the account of their master or employer; or who shall fraudulently embezzle, secrete, or make away with the same, or any part thereof; every such offender, shall be deemed to have feloniously stolen the same from his master or employer, for whose use, or on whose account the same was delivered to, or taken into the possession of such servant, clerk, or other person so employed, although such money, goods, bond, bill, note, banker's draft, or other valuable security, was or were no otherwise received into the possession of his or their servants, clerk, or other person so employed; and every such offender, his adviser, procurer, aider, or abetter, being thereof lawfully convicted or attainted, shall be liable to be transported beyond seas.

EMBLEM, a kind of painted enigma, or certain figures painted or cut metaphorically, expressing some action, with reflections underneath, which, in some measure, explain the sense of the device, and at the same time, instruct us in some moral truth, or other matter of knowledge. The emblem is somewhat plainer than the enigma, and the invention is more modern, it being entirely unknown to the ancients.

EMBLEMENTS, in law, signify the profits of land sown; but the word is sometimes used more largely, for any profits that arise and grow naturally from the ground, as grass, fruit, hemp, flax, &c.

EMBOLISMIC, or *intercalary*, a term used by chronologists in speaking of the additional months and years, which they insert to bring the lunar to the solar year. Since the common lunar year consists of twelve synodic months, or 354 days nearly, and the solar consists of 365 days (throwing away the odd hours and minutes) it is plain that the solar year will exceed the lunar by about 11 days; and consequently in the space of about 33 years, the beginning of the lunar year will be carried through all the seasons, and hence it is called the moveable lunar year. This form of the year is used at this time by the Turks and Arabians; and because in three years' time the solar year exceeds the lunar by 33 days, therefore, to keep the lunar months in the same seasons and times of the solar year, or near it, chronologists added a whole month to the lunar year every third year, and so made it consist of 13 months; this year they called the embolismic year, and the additional month the embolismic, or embolimean, or intercalary month. This form of the year is called the fixed lunar year, and it was used by the Greeks and Romans till the time of Julius Cæsar.

EMBOSSING, or IMBOSSING, in architecture and sculpture, the forming or fashioning works in relievo, whether cut with a chissel or otherwise. Embossing is a kind of sculpture, wherein the figures stick out from the plane whereon it is cut; and according as the figures are more or less prominent, they are said to be in alto, mezzo, or basso relievo; or high, mean, or low relief.

EMBOTHRIUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Proteæ, Jussieu. Essential character: corolla four-petalled; an-

thers sessile, sitting on the tips of the petals; follicle round. There are four species.

EMBRACERY, is an attempt to corrupt or influence a jury, or any way incline them to be more favourable to the one side than the other, by money, promises, letters, threats, or persuasions; whether the juror, on whom such attempt is made, give verdict or not, or whether the verdict given be true or false, which is punished by fine and imprisonment; and the juror taking money, perpetual infamy, imprisonment for a year, and forfeiture of tenfold the value.

EMBRASURE, in fortification, a hole or aperture in a parapet, through which the cannon are pointed to fire into the moat or field. Embrasures are generally twelve feet distant from one another, every one of them being from six to seven feet wide without, and about three within: their height above the platform is three feet on that side towards the town, and a foot and a half on the other side towards the field; so that the muzzle may be sunk on occasion, and the piece brought to shoot low.

EMBROCATION, in surgery, an external kind of remedy, which consists in an irrigation of the part affected with some proper liquor, as oils, spirits, &c. by means of a woollen or linen cloth, or a spunge, dipped in the same. The use of embrocation is either to attenuate and dislodge something obstructed underneath the skin, to ease pains, or to irritate the part into more warmth and a quicker sense of feeling. The pumping used in natural baths is properly an embrocation.

EMBROIDERY, a work in gold, or silver, or silk thread, wrought by the needle upon cloth, stuff, or muslin, into various figures. In embroidering stuffs, the work is performed in a kind of loom, because the more the piece is stretched, the easier it is worked. As to muslin, they spread it upon a pattern ready designed; and sometimes, before it is stretched upon the pattern, it is starched to make it more easy to handle. Embroidery on the loom is less tedious than the other, in which, while they work flowers, all the threads of the muslin, both lengthwise and breadthwise, must be continually counted; but on the other hand, this last is much richer in points, and susceptible of greater variety. Cloths too much milled are scarce susceptible of this ornament, and in effect we seldom see them embroidered. The thinnest muslins are left for this purpose, and they are embroidered to the greatest perfection in Saxony; in other parts of Europe, however, they embroider very prettily, and especially in France.

There are several kinds of embroidery, as, 1. Embroidery on the stamp, where the figures are raised and rounded, having cotton or parchment put under them to support them. 2. Low embroidery, where the gold and silver lie low upon the sketch, and are stitched with silk of the same colour. 3. Guimped embroidery: this is performed either in gold or silver; they first make a sketch upon the cloth, then put on cut vellum, and afterwards sew on the gold and silver with silk thread: in this kind of embroidery they often put gold and silver cord, tinsel, and spangles. 4. Embroidery on both sides; that which appears on both sides of the stuff. 5. Plain embroidery, where the figures are flat and even, without cords, spangles, or other ornaments.

EMBROIDERY, no foreign embroidery, on gold or silver brocade, is permitted to be imported into this kingdom on pain of being seized and burned, and a penalty of 100*l.* for each piece.

EMBRYO, in physiology, the first rudiments of an animal in the womb, before the several members are distinctly formed; after which period it is denominated a fœtus. See FŒTUS and MIDWIFERY.

EMBRYO, in botany. See CORCULUM.

EMERALD. This mineral comes chiefly from Peru; some specimens have been brought from Egypt. Dolomieu found it in the granite of Elba. Hitherto it has been found only crystallized. The primitive form of its crystals is a regular six-sided prism; and the form of its integrant molecules is a triangular prism, whose sides are squares, and bases equilateral triangles. The most common variety of its crystals is the regular six-sided prism, sometimes with the edges of the prism, or of the bases, or the solid angles, or both wanting, and small faces in their place.

Crystals short; lateral planes smooth, terminal planes rough; colour emerald green of all intensities; internal lustre between 3 and 4; vitreous; fracture small, imperfect, conchoidal, with a concealed foliated fracture, and fourfold cleavage; fragments sharp-edged; transparency 4 to 2; causes double refraction; scratches quartz with difficulty. Specific gravity from 2.600 to 2.7755.

The fossil here described is the occidental emerald, and appears from antique gems to have been known in the earlier ages, though

at present it comes to us only from South America. Vauquelin found it to contain of silex 64.5, argil 16, glucine 13, oxide of chrome 3.25, lime 1.6, and water 2. The oriental emerald is a green corundum, or resplendent lustre, superior in hardness to every stone but the diamond, and of the specific gravity of 4.

EMERSION, in astronomy, is when any planet that is eclipsed begins to emerge or get out of the shadow of the eclipsing body. It is also used when a star, before hidden by the sun as being too near him, begins to re-appear or emerge out of his rays.

EMERSON (William), in biography, a late eminent mathematician, was born in June, 1701, at Hurworth, a village about three miles south of Darlington, on the borders of the county of Durham; at least it is certain that he resided here from his childhood. His father, Dudley Emerson, taught a school, and was tolerably proficient in mathematics; and, without his books and instructions, perhaps his son's genius, though eminently fitted for mathematical studies, might never have been unfolded. Beside his father's instructions, our author was assisted in the learned languages by a young clergyman, then curate of Hurworth, who was boarded at his father's house. In the early part of his life he attempted to teach a few scholars; but whether from his concise method, for he was not happy in explaining his ideas, or the warmth of his natural temper, he made no progress in his school; he therefore soon left it off, and, satisfied with a moderate competence left him by his parents, he devoted himself to a studious retirement, which he thus closely pursued, in the same place, through the course of a long life, being mostly very healthy, till towards the latter part of his days, when he was much afflicted with the stone. About the close of the year 1781, being sensible of his approaching dissolution, he disposed of his whole mathematical library to a bookseller at York; and on May the 20th, 1782, his lingering and painful disorder put an end to his life, at his native village, being nearly 81 years of age.

Mr. Emerson, in his person, was rather short, but strong and well made, with an open countenance and ruddy complexion, being of a healthy and hardy disposition; he was very singular in his behaviour, dress, and conversation; his manner and appearance were that of a rude and rather boorish countryman; he was of very plain conversation, and seemingly rude, commonly mixing oaths in his sentences, though without any ill intention; he had strong good natural mental parts, and could discourse sensibly on any subject, but was always positive and impatient of contradiction; he spent his whole life in close study, and writing books, from the profits of which he redeemed his little patrimony from some original incumbrance; in his dress he was as singular as in every thing else; he possessed commonly but one suit of cloaths at a time, and those very old in their appearance; he seldom used a waistcoat; and his coat he wore open before, except the lower button; and his shirt quite the reverse of one in common use, the hind side turned foremost, to cover his breast, and buttoned close at the collar behind; he wore a kind of rusty coloured wig, without a crooked hair in it, which probably had never been tortured with a comb from the time of its being made; a hat he would make to last him the best part of a life-time, gradually lessening the flaps, bit by bit, as it lost its elasticity and hung down, till little or nothing but the crown remained.

He often walked up to London when he had any book to be published, revising sheet by sheet himself: trusting no eye but his own, was always a favourite maxim with him. In mechanical subjects, he always tried the propositions practically, making all the different parts himself on a small scale; so that his house was filled with all kinds of mechanical instruments, together or disjointed. He would frequently stand up to his middle in water while fishing, a diversion he was remarkably fond of. He used to study incessantly for some time, and then for relaxation take a ramble to any pot ale-house where he could get any body to drink with, and talk to. The late Mr. Montague was very kind to Mr. Emerson, and often visited him, being pleased with his conversation, and used frequently to come to him in the fields where he was working, and accompany him home, but could never persuade him to get into a carriage: on these occasions he would sometimes exclaim, "Damn your whim-wham! I had rather walk." He was a married man, and his wife used to spin on an old-fashioned wheel, of his own making, a drawing of which is given in his "Mechanics."

Mr. Emerson, from his strong, vigorous mind and close application, had acquired deep knowledge of all the branches of mathematics and physics, upon all parts of

which he wrote good treatises, though in a rough and unpolished style and manner. He was not remarkable, however, for genius or discoveries of his own, as his works hardly shew any traces of original invention. He was well skilled in the science of music, the theory of sounds, and the various scales both ancient and modern; but he was a very poor performer, though he could make and repair some instruments, and sometimes went about the country tuning harpsichords.

The following is the list of Mr. Emerson's works, all of them printed in 8vo., excepting his "Mechanics" and his "Increments," in 4to., and his "Navigation" in 12mo. 1. The Doctrine of Fluxions. 2. The Projection of the Sphere, Orthographic, Stereographic, and Gnomonical. 3. The Elements of Trignometry. 4. The Principles of Mechanics. 5. A Treatise of Navigation on the Sea. 6. A Treatise on Arithmetic. 7. A Treatise on Geometry. 8. A Treatise of Algebra, in two books. 9. The Method of Increments. 10. Arithmetic of Infinities, and the Conic Sections, with other Curve Lines. 11. Elements of Optics and Perspective. 12. Astronomy. 13. Mechanics, with Centripetal and Centrifugal Forces. 14. Mechanical Principles of Geography, Navigation, and Dialling. 15. Commentary on the Principia, with the Defence of Newton. 16. Tracts. 17. Miscellanies.

EMERY, a stone of the ruby family, of which three kinds are usually distinguished in commerce; the Spanish, red, and common emery. The first sort is found in the gold mines of Peru, and being judged a kind of marcasite of that rich metal, is prohibited to be exported. The red emery is found in copper mines, and the little there is of it in England comes from Sweden and Denmark. The common emery is taken out of iron mines, and almost the only sort used in England; it is of a brownish colour, bordering a little on red, exceedingly hard, and in consequence difficult to pulverize. The English are the only people who have the art of reducing common emery into powder, and thus send it to their neighbours. Of the powder, the most subtile and impalpable is the best; as to the stone, it should be chosen of a high colour, and as free of the rock as possible.

The consumption of emery is very considerable among the armourers, cutlers, locksmiths, lapidaries, masons, and other mechanics; some of whom use it to polish and burnish iron and steel works; others, to cut and scallop glass, marble, and precious stones.

EMETIC, a medicine which induces vomiting.

EMETIC *tartar*, the old name for tartrite of antimony.

EMOLLIENTS. See PHARMACY.

EMPETRUM, in botany, *heath*, a genus of the Dioecia Triandria class and order. Natural order of Ericæ, Jussieu. Essential character: male, calyx three-parted; corolla three-petalled; stamens long: female, calyx three-parted; corolla three-petalled; styles nine; berry nine-seeded. There are two species; *viz.* E. album, white-berried heath, and E. nigrum, black-berried heath, crow or crake berry. These are low shrubs, seldom propagated in gardens, unless for variety's sake. They are natives of wild mountains, where the soil is heathy and full of bogs.

EMPIS, in natural history, a genus of insects of the order Diptera. Generic character: mouth with an inflected sucker and proboscis; sucker with a single-valved sheath and three bristles; feelers short, filiform; antennæ setaceous. These minute insects live likewise by sucking out the blood and juices of other animals. There are about 30 species. One of the most common species is the E. livida, which is a brownish fly; the wings are transparent, with dark veins. They are observed in fields and gardens. E. borealis, is of a more slender form than the common window fly, and of a blackish colour, with large, broad, oval wings, of a brown colour, and rufous legs, varied with black.

EMPLASTRUM, in pharmacy, a composition for external use, generally spread upon leather, linen, or some other convenient thing before it is applied. See PHARMACY. The following is a recipe for making the Ladies' Court Plaster: "Dissolve five ounces of isinglass in a pint of water, and having ready a quantity of thin black sarsenet, stretched in a proper frame, apply the solution warm with a brush equally over the surface. This is to be repeated, after it is dry, two or three times." Some give it a coat of gum benzoin dissolved in alcohol; but this is injurious rather than beneficial.

EMPLEURUM, in botany, a genus of the Monoecia Tetrandria class and order. Natural order of Aggregatæ. Rutaceæ, Jussieu. Essential character: male, calyx four-cleft; corolla none: female, calyx four-cleft, inferior; corolla none; stigma cylindric, placed on the lateral toothlet of the

germ; capsule opening on the side; seed one, arilled. There is but one species; *viz.* E. serrulatum, Cape empleurum. This is a shrub, with wand-like, even branches; leaves like those of a willow, alternate, subpetioled, linear-lanceolate, even above, beneath longitudinally wrinkled; peduncles few-flowered, lateral, much shorter than the leaves; flowers small, most of them male; capsules usually solitary, incurved, with a beak of the same length.

EMULSION, a milky looking fluid caused by an imperfect combination of oil with water by means of mucilage, gluten, &c. All oily farinaceous seeds, as nuts, almonds, linseed, &c. form an emulsion by trituration with water: yolk of egg, which is a natural compound of oil and albumen, makes a similar emulsion.

ENAMELLING. Neri on Glass, with the notes of Merret and Kunckel, afford a variety of good receipts for making enamels, though much still remains to be done in this art. The art is indeed retarded by the considerable advantages the enameller derives from the discovery of any colour uncommonly brilliant, clear, or hard. On this account the artist naturally endeavours to keep his process a secret, as the source of private gain. The principal ingredients of enamel colours are, however, well known.

There are two kinds of enamel; the opaque and the transparent. Transparent enamels are usually rendered opaque by adding putty, or the white oxide of tin, to them. The basis of all enamels is therefore a perfectly transparent and fusible glass. The oxide of tin renders this a beautiful white, the perfection of which is greater when a small quantity of manganese is likewise added. If the oxide of tin be not sufficient to destroy the transparency of the mixture, it produces a semi-opaque glass, resembling the opal.

Yellow enamel is formed by the addition of oxide of lead or antimony. Kunckel likewise affirms that a beautiful yellow may be obtained from silver.

Red enamel is formed by the oxide of gold, and also by that of iron. The former is the most beautiful, and stands the fire, which the latter does not.

Oxide of copper affords a green, manganese a violet, cobalt a blue, and iron a very fine black. A mixture of these enamels produces a great variety of intermediate colours, according to their nature and proportion. In this branch of the art the coloured enamels are sometimes mixed with each other, and sometimes the oxides are mixed before they are added to the vitrious bases.

The enameller who is provided with a set of good colours is very far from being in a situation to practise the art, unless he be skilled in the methods of applying them, and the nature of the grounds upon which they are to be laid. Many of the metals are too fusible to be enamelled, and most of them are corroded by the action of the fused glass. For this reason none of the metals are used but gold, silver, and copper. Platina has indeed been used; but of its effects and habitudes with enamel very little can be said, for want of a sufficient number of experiments.

The purest gold, of 24 carats, is calculated to produce the best effect with enamel. 1. Because it entirely preserves the metallic brilliancy, without undergoing any oxidation in the fire. 2. Being less fusible, it will admit of a more refractory, and consequently a harder and more beautiful enamel. It is not usual, however, to enamel on finer gold than 22 carats; and the operation would be very defective, if a coarser kind than that of 18 carats were used. For in this case more alkali must be added to the enamel to render it more fusible, and this addition would, at the same time, render it softer and less brilliant.

Rejecting all these exceptions, the following description may be taken, by way of example, of fixing a transparent blue enamel upon gold of 22 carats.

The artist begins his operation by breaking his enamel into small pieces in a steel mortar, and afterwards pulverizing it in a mortar of agate. He is careful to add water in this part of the process, which prevents the splinters of glass from flying about. There are no means of explaining the point at which the trituration ought to be given up, as this can be learned only by experience. Some enamels require to be very finely triturated; but others may be used in the form of a coarse powder. As soon as he apprehends that his enamel is sufficiently pounded, he washes it by agitation in very clear water, and pouring off the fluid as it becomes turbid. This process, which is made for carrying off dust and every other impurity from the enamel, is continued until the water comes off as clear as it was poured on.

The workman puts his enamel thus prepared into a white earthen or china saucer, with water poured on it to the depth of

about one-tenth of an inch. He afterwards takes up the enamel with an iron spatula as equally as possible. As the enamel here spoken off is transparent, it is usual to ornament the gold with rose work, or other kinds of work, calculated to produce a good effect through the enamel.

The thickness of this first layer depends entirely upon its colour: delicate colours in general require that it should have no great thickness.

The moist enamel being thus placed, is dried by applying a very clean half-worn linen cloth to it, which must be very carefully done to avoid removing the enamel by the action of wiping.

In this state the piece is ready for the fire. If it be enamelled on both sides, it is placed upon a tile, or iron plate, hollowed out in such a manner that the uncovered edges of the piece alone are in contact with the support. But if it be enamelled on one side only, it is simply laid upon the plate, or upon a tile. Two things, however, require to be attended to. 1. If the work be very small, or not capable of being enamelled on the opposite side, the iron plate must be perfectly flat, in order that the work may not bend when softened by heat. 2. If the work be of considerable size, it is always counter-enamelled, if possible; that is to say, an enamel is applied on the back surface, in order to counteract the effect which the other coating of glass might produce on the soft metal when it came to contract by cooling.

The enameller's furnace is square, and built of bricks bedded in an earth proper for the purpose. It may be considered as consisting of two parts, the lower part which receives a muffle resting on the floor of the furnace, and open on both sides.

The upper part of the furnace consists of a fire place, rather larger and longer than the dimensions of the muffle. The fire place contains the muffle, and must surround it on all sides, except at the bottom. The charcoal is put in at a door above the muffle, which is closed as soon as the fire is lighted. A chimney proceeds from the summit of the furnace with a moderate aperture, which may be closed at the pleasure of the artist, by applying a cast iron plate to it. This furnace differs from that of the assayer, in the circumstance that it is supplied with air through the muffle itself: for if the draught were beneath the muffle, the heat would be too strong, and could not be stopped when requisite.

As soon as the fire is lighted, and the muffle has acquired the requisite degree of ignition, the charcoal is disposed towards the lower part of the muffle in such a manner as that it shall not fall upon the work, which is then conveyed into the muffle with the greatest care upon the plate of iron or earthern-ware, which is taken out by long spring pincers. The work is placed as near as possible at the farther extremity of the muffle; and as soon as the artist perceives a commencement of fusion, he turns it round with great delicacy, in order that the fusion may be very uniform. And as soon as he perceives that the fusion has entirely taken place, he instantly removes it out of the furnace: for the fusion of gold happens so very near to that of the enamel, that the neglect of a few seconds might be attended with considerable loss.

When the work is cooled, a second coat of enamel is applied in the same manner as the first, if necessary. This and the same cautious management of the fire are to be repeated for every additional coat of enamel the nature of the work may demand.

As soon as the number of coatings are sufficient, it becomes necessary to give an even surface to the enamel, which though polished by the fire, is nevertheless irregular. This is done with a fine grained Lancashire file, and water. As the file wears smooth, sand is used. Much precaution and address are required in this part of the work, not only because it is easy to make the enamel separate in splinters from the metal, but likewise because the colour would not be uniform if it were to be ground thinner at one part than at another.

The deep scratches of the file are in the next place taken out by rubbing the surface with a piece of deal wood and fine sand and water. A polish is then given by a second ignition. This polish, however, is frequently insufficient, and not as perfectly uniform as the delicacy of the work may require.

The substance used by the enamellers as a polishing material is known by the name of rotten-stone, which is prepared by pounding, washing, decanting off the turbid water, suffering the fine suspended particles to subside from this water, and lastly levigating it upon a glass plate.

The work is then cemented to a square piece of wood, with a mixture of resin and brickdust, and by this means fixed in a vice.

The first operation of polishing is made

by rubbing the work with rotten-stone upon a small straight bar of pewter. Some delicacy is here required to avoid scratching or producing flaws in the enamel by pressing too hard. In this way the piece is rendered perfectly even. But the last brilliant polish is given by a piece of deal wood and the same rotten-stone.

This is the general method of applying enamel; but some colours require more precaution in the management of the fire. Opaque colours require less management than the transparent. A variety of circumstances must be attended to in transparent colours; every colour requires gold of a particular fineness.

When different colours are intended to be placed beside one another, they are kept separate by a small edge or prominency, which is left in the gold for that purpose, and is polished along with the enamel.

The enamelling upon silver is effected nearly in the same manner as that of gold; but the changes sustained by the colours upon silver by the action of the fire are much more considerable than when gold is used.

Copper is not much used by enamellers, on account of the difficulty which attends the attempt to fix beautiful colours upon it. When this metal is used, the common practice is to apply a coating of opaque white enamel, and upon this other colours which are more fusible than the white.

A good effect is produced in toys by leaving part of the gold bare. For this purpose its surface is cut into suitable compartments by the engraver. This, however, is an expensive method, and is for this reason occasionally imitated by applying small and very thin pieces of gold upon the surface of the enamel, where they are fixed by the fire, and afterwards covered by a transparent vitreous coating.

A method of taking off the enamel from any toy without injuring the metallic part, is often a desirable object. For this purpose a mixture of common salt, nitre, and alum in powder, is applied upon the enamel, and the piece is put into the furnace. As soon as the fusion has taken place, the piece is to be suddenly thrown into water, which causes the enamel to fly off, either totally or in part. Any part which may still remain is to be removed by repeating the same operation a second time.

To coat vessels of iron or copper for culinary purposes with an enamel capable of defending the metal from the action of any solvent, and for enduring any heat or transition from heat to cold, appears a desirable object; and many experiments have been made on the subject by Mr. Soen Rinman of the Royal Academy of Stockholm.

The following compositions he found answer very well on copper. 1. The white semitransparent fluor spar and sulphate of lime in equal quantities, powdered, mixed, and calcinated in a white heat; then powdered, made into a thin paste with water, and applied a little warm to the vessel also warmed. Then dried and heated gradually to a certain point, a very strong heat, greater than is generally obtained in an assaying furnace, is to be applied as quickly as possible. 2. Sixty parts of lime, one hundred of fluor spar, sixty of gypsum, twenty of quartz, and one of manganese are calcinated, ground, and applied in a similar manner. 3. Four parts of fluor spar, four of gypsum, and one of litharge, melted into a straw-coloured glass, ground and applied in the same way, required a much stronger heat. 4. Five parts of fluor spar, five of gypsum, two of minium, two of flint glass, half a part of borax, the same of oxide of tin, and one twenty-fifth of a part of oxide of cobalt melted together made an enamel; which, when ground, and applied as the others, fused with a less degree of heat. This, Mr. Rinman imagines, would have been acted upon in length of time by sulphuric acid. The oxide of cobalt was prepared by saturating a solution of cobalt in aqua-fortis with common salt, and evaporating to dryness.

As these would not do for iron, he tried the following: 1. minium, nine parts; flint glass, six; pure potash, two; nitre, two; borax, one; were ground together, put into a covered crucible, which they only half filled and fused into glass. This poured out on a piece of marble, quenched in water, powdered and made into a thin paste, was laid on both sides of an iron vessel. After having been dried and heated gradually, the vessel was put under a muffle, well heated in an assaying furnace, and in half a minute the enamel melted. The vessel being then withdrawn, was found enamelled of a beautiful black colour, which appeared to be owing to a thin layer of oxided iron seen through the transparent glaze. 2. The same, with one hundredth part of oxide of cobalt prepared as above, covered the vessel more perfectly with a blue enamel. 3. The same ground with

potters' white lead, which consists of four parts of lead and one of tin, produced a very smooth grey enamel, more firm and hard than the preceding. A small quantity of red oxide of iron gave it a fine dark red colour. 4. Flint glass, twelve parts; minium, eighteen; potash, four; nitre, four; borax, two; oxide of tin three; oxide of cobalt, one-eighth of a part, gave a smooth pearl coloured enamel, not brittle or subject to crack, and capable of enduring sudden changes of heat and cold, as well as the action of oils, alkalies, and weak acids; but it cannot resist the stronger vegetable acids, and still less the mineral.

These enamels were applied only on hammered iron, cast iron being too thick to be heated with sufficient quickness. But they have been applied to the thin cast vessels in England. It seems unnecessary to add, none of them will bear hard blows; and this is perhaps the reason why they have not been more used with us.

The application of enamel colours to glass or earthenware constitutes a peculiar branch of the art. M. Brougniart, of the porcelain manufactory at Sèvres, has given a good account of them. (Nicholson's Journal, Vol. III. 4to.)

These bodies may be divided into three very distinct classes from the nature of the substances that compose them, the effects produced on them by the colours, and the changes they undergo. These are, 1. enamel; soft porcelain, and all the glazes, enamels, or glasses, which contain lead in any considerable quantity. 2. Hard porcelain, or such as is glazed with feldspar. 3. Glass, in which there is no lead, such as the common window glass. The principles of composition of these colours, and the general phenomena they present on these three grounds or supporters, are regularly treated of.

Colours in enamel painting have been longest known. Enamel is a glass rendered opaque by oxide of tin, and very fusible by the oxide of lead. It is this last which in particular gives it properties very different from those of the other excipients of metallic colours. Hence all the glasses and glazes which contain lead, have the properties of enamel, and what we may assert of the one will apply to the other with very little difference.

Such are the white and transparent glazes of Dutch or Delft ware, and the glaze of the porcelain called soft ware.

This porcelain, the first made in France, particularly at Sèvres, and indeed for a long time almost exclusively at that manufactory, has for its base vitreous frit nearly opaque, capable of being acted upon by marl, and its glaze is a very transparent glass containing much lead.

The colours made use of are the same as those for enamelling, consequently the changes these colours undergo in enamel must take place in this species of porcelain. The causes of the change being the same in both.

The colours for enamel and soft porcelain require less flux than the others, because the glass on which they are placed softens sufficiently to be penetrated by them.

This solvent may be either the mixture of glass of lead and pure silex, called rocaille, or this same glass mixed with that of borax.

Montamy says, that glass of lead ought not to be used in the flux for enamel; he employs borax alone. He then dilutes or makes up his colours in a volatile oil.

On the contrary, the painters of the manufactory at Sévres use only colours without borax, because they dilute them with gum, and borax does not dilute them well this way. M. Brougniart is convinced that both methods are equally good, and that Montamy is not justified in excluding the fluxes of lead, as they are employed without inconvenience every day, and even render the management of colours more easy.

It is remarked, that in the baking of these colours the glaze is softened so much as to be easily penetrated by them; and this is one great cause of the change they undergo. They become diluted by the mixture with the glaze, and the first fire changes a painting apparently finished, into a very slight sketch.

The oxide of lead contained in the glaze is a more powerful cause of the great changes these colours undergo. Its destructive action is principally exercised on the reds of iron, and is very remarkable.

It has already been shewn that the two principal causes of the change which colours on enamel and tender porcelain undergo, do not relate to the composition of these colours, but entirely to the nature of the glass on which they are placed. The assertion that the colours of porcelain are subject to considerable change, relates to the colours of soft porcelain, a species of ware now almost totally abandoned.

Hence, it follows, that the paintings of porcelain require to be several times retouched and burned, in order to possess the

necessary strength. Though these paintings have always a certain softness, they are constantly more brilliant, and never subject to the inconvenience of scaling off.

Hard porcelain is the second species of ground or excipient for the metallic colours. It is known that the base of this porcelain is a very white argil, called kaolin, mixed with a siliceous and calcareous solvent, and the glaze is nothing but feldspar fused without an atom of lead.

This porcelain, which is that of Saxony, is of a much later date at Sévres than the soft or tender. The colours employed are of two kinds, the first used for representing different objects are baked with a very inferior fire to that required for baking the porcelain itself. They are very numerous and varied.

The others, which require to be fused at as great a heat as that for baking the porcelain, are laid on the general surface. They are much less numerous.

The colours for painting are made up very nearly of the same materials as those for tender porcelain; they only contain more flux. This flux is composed of the glass of lead (called rocaille) and of borax. M. Brougniart asserts, that he has not met with any work that treats of the composition, use, and effects of these colours. In fact, it has no where been asserted, in print, that all these colours, except one, are unchangeable in fire; whereas it has been often asserted, in books, that paintings in enamel are subject to considerable change.

When the porcelain is put into the fire to bake the colours, the feldspar glaze dilates and opens in pores, but does not become soft. As the colours do not penetrate it, they are not subject to the changes they undergo on tender porcelain. It must, however, be observed, that they lose a little of their intensity by acquiring the transparence given them by the fusion.

When works of little importance are made, they need not be re-touched; but this is necessary when a painting is to be highly finished. This re-touching is not more distinguishable in paintings on porcelain than in that of any other species of painting.

One of the great inconveniences of these colours is, that they scale or fly off when the fire is often applied.

This has been particularly remarked at Sévres, on account of the solidity and infusibility with which porcelain is there manufactured. But these qualities cause it to resist the alterations of heat and cold for a longer time, and gives its ground a more brilliant colour. On the other hand, the porcelains of Paris being more vitreous, transparent, and of a blueish cast, generally crack if boiling water is frequently poured into them.

In order to remedy this evil, without altering the quality of the body, Brougniart softens the glaze a little, by introducing more siliceous or calcareous flux according to the nature of the feldspar. This method succeeded, and for twelvemonths then past, the colours had past two and three times through the fires without cracking, provided there were not too much flux, and they were not laid on too thick.

It has been remarked, that when soda and potash have been introduced, the colours scaled, so that they cannot be used as fluxes. These alkalies being volatilized, abandon the colours which cannot adhere to the glaze by themselves.

It has been observed, that other colours are likewise prepared, which being laid upon the general surface, are fused by the same fire as bakes the porcelain. These colours are but few, because there are few metallic oxides that can support such a fire without being volatilized or discoloured. Their solvent is the feldspar. As they incorporate with the glaze they never crack, and are more brilliant.

The third receptacle of metallic vitrifiable colours is glass without lead.

The application of these colours constitutes the art of painting upon glass; an art much practised in former ages, but which was, till lately, supposed to be lost, because out of fashion. It, however, too immediately depends on the art of painting on enamel and porcelain to be lost. Descriptions of the processes may be found in different books.

A book entitled, "L'Origine de l'art de la Peinture sur Verre," published at Paris in the year 1693, and "Le Traité de l'art de la Verriere," by Neri and Kunckel, seem to be the first works containing complete descriptions of this art. Those published since, even the great work of Leviel, which constitutes part of "Les Arts et Metiers," of the French academy, and of the "Encyclopédie Methodique," are only compilations from the two former works.

It is somewhat remarkable, that if we follow the processes exactly as they are described in these works, as our author has done with some of them, the colours of

which they pretend to give the receipt would never be fabricated. They only serve to shew an able practitioner the method, and leave it to him to correct or make additions. This was found to be the case by Citizen Meraud, who was engaged to prepare them for the manufactory of Sévres. He was obliged to make the colours for painting on glass rather from his own experience than from the instructions in the work just mentioned.

The materials and fluxes which enter into the compositions of the colours for painting on glass are, in general, the same as those applied to porcelain. They vary only in their proportions; but a great number of the colours used for enamel and porcelain cannot be applied on glass; many of them, when seen by transmitted light, entirely change their aspect, and exhibit an obscure tint, which can be of no use when deprived of the white ground which throws them out. We shall point out these when we treat of the colours in particular. Those colours which can be used on this body sometimes change in the baking, and acquire a great transparency. They are generally beautiful only when placed between the eye and the light, and they answer the purpose intended in painting glass.

There is more difficulty in baking plates of coloured glass than is commonly thought. The bending of the piece, and the alteration of the colours, are to be avoided. All the treatises we have consulted recommend the use of gypsum. This method sometimes succeeded with Brougniart, but generally the glass became white, and cracked in all directions. It appears, that the glasses which are too alkaline, and which are far the most common in clear white glasses, are attacked by the hot sulphuric acid of the sulphate of lime. He was able with ease to bake much larger glasses than any before painted, by placing them on very smooth plates of earth or unglazed porcelain.

Concerning the several particular Colours.

After having collected the several phenomena which each class of vitrifiable colours offer with regard to the bodies on which they are placed, we must shew the particular and most interesting phenomena which every principal species of colours employed on tender porcelain, on glass, and in the fire that bakes the porcelain present.

Concerning the Reds, Purples, and Violets obtained from Gold.

The carmine-red is obtained from the purple precipitate of Cassius. It is mixed with about six parts of its flux, and this mixture is directly employed without being first fused. It is then of a dirty violet, but acquires the beautiful carmine by baking. It is however very delicate; a little too much heat or carbonated vapours easily spoil it; yet it is more beautiful when baked with charcoal than with wood.

This colour, and the purple which differs little from it, as well as the shades which are obtained from their mixture with other colours, really change in all porcelains, and in the hands of all operators. But this is the only one which changes on hard porcelain. It may be replaced by a substitution of rose colour from iron, which does not change; so that by excluding from the pallet the carmine made from gold, and substituting the rose-coloured oxide of iron here spoken of, we have a pallet composed of colours, none of which are subject to any remarkable change. The rose-coloured oxide of iron has been long known, but was not employed on enamel, because it is then subject to considerable change. Or perhaps, when the painters on enamel became painters on porcelain, they continued to work according to their ancient method.

It might be supposed, that by previously reducing the colour named carmine, already mixed with its solvent into a vitreous matter, the last tint would be obtained; but the fire which must be used to melt this vitreous mass destroys the red colour. Besides, it is found that to obtain this colour in perfection, it is necessary to pass it through the fire as little as possible.

The carmine of tender porcelain is made of fulminating gold, gently decomposed, and muriate of silver; there is no tin in it, which proves it is not necessary for the fabrication of a purple colour that the oxide of this last metal, and that of gold, should be combined.

Violet is likewise obtained from the purple oxide of gold. This colour proceeds from having a greater quantity of lead in the flux, and it is nearly of the same tint, whether crude or baked.

These three colours totally disappear in the strong fire necessary to bake porcelain.

Carmine and purple afforded, upon glass, only tints of a dirty violet. The violet on the contrary has a beautiful effect, but is subject to change to blue.

Concerning the Red, Rose, and Brown Colours, obtained from Iron.

These colours are made from red oxydated iron, prepared with nitric acid. The oxides are calcined still more by exposing them to the action of fire. If too much heated they change to a brown.

Their flux is composed of borax and minium in small quantity.

These are the oxides which afford the rose and red colours, which may be substituted instead of the same colours made from oxide of gold. If properly applied on hard porcelain they never change. Brougman made roses with these colours, and there was no difference between the flower before and after baking, except the brilliancy which colours naturally receive from fusion.

The colours may either be previously fused or not, at pleasure.

In a violent fire, they either partly disappear, or produce a dull and brick-dust red colour, which is not at all agreeable.

Their composition is the same, either for tender porcelain or for glass. They do not change on the latter, but on the former they almost entirely disappear by the first fire; and they must be laid on very heavily in order to have any part visible.

It is to the presence of lead in their glaze that this singular effect must be attributed. Brougman ascertained this by a very simple experiment. He placed this colour on window glass, and fired it very strongly and it did not change. He then covered some parts of it with minium, and again exposed it to the fire. The colours totally disappeared in those places where the red oxide of lead had been applied. When this experiment was performed on a larger scale, in a closed vessel, a large quantity of oxygen gas was disengaged.

This observation seems clearly to prove the effect of oxyded lead as a discolourer of glass. We see that it does not operate as has been supposed, by burning combustible impurities in the glass, but by dissolving, discolouring, and volatilizing the oxide of iron, which may effect its clearness.

Concerning the Yellows.

Yellows are colours which require much precaution in fabricating, on account of the lead they contain; which, sometimes, by approaching to the metallic state produces black spots.

The yellows of hard and tender porcelain are the same. They are composed of oxide of lead, white oxide of antimony, and sand. Oxide of tin is sometimes added; and when it is required very lively and resembling the colour of marigold, red oxide of iron is added, the very deep colour of which disappears during the previous fusion they undergo, on account of the lead contained in this yellow. When these colours are once made they do not change; they disappear almost entirely in the porcelain fire-yellows.

These cannot be applied to glass, they are opaque and muddy. That employed by the ancient painters on glass is, on the contrary, beautifully transparent, very brilliant, and of a colour approaching gold. The processes they give indicate that it contains a mixture of silver; but when exactly followed they afford nothing satifactory. Citizen Meraud succeeded in making it as beautiful as the ancient painters on glass, by employing muriate of silver, oxide of zinc, white clay, and the yellow oxide of iron. These colours are applied to glass simply ground and without flux. The oxide of iron gives the yellow nearly the same tinge as it ought to have after the baking, and contributes, with the clay and oxide of zinc, to decompose the muriate of silver without disoxydating the silver itself. A powder remains after baking which does not penetrate the glass, and may be easily cleared off.

This yellow when employed in greater quantities affords deeper shades, and produces a reddish colour.

Concerning the Blues.

These are known to be obtained from the oxide of cobalt; their preparation is known to every chemist. The superiority at Sèvres, so justly reputed for the superiority of its blues, is owing merely to the care taken in its fabrication, and to the quality of the porcelain, which appears more proper to receive it on account of the violent fire it can support.

Brougniart observed one fact respecting the oxide of cobalt, which is, perhaps, not known to every chemist. It is volatile in a violent heat; to this property must be attributed the bluish tint which the white (bordering upon blue) always receives. A white piece was purposely put in the same case next to a blue, the side of the white piece which was turned towards the blue became very bluish.

The blue of hard porcelain, prepared for what is called a blue ground by strong fire,

is fused with feld-spar; the solvent for tender porcelain is silex, potash, and lead; it is not volatilized like the preceding, because the fire is much inferior to that of the hard porcelain.

These colours being previously fused do not in the least change when applied.

The blues for glass are the same as for tender porcelain.

Concerning Greens.

The greens, employed in painting, are made with the green oxide of copper, or sometimes with a mixture of yellow and blue. They must be previously melted with their flux; without this precaution they would become black; but they do not change after the first fusion.

They must not be treated with a violent fire or they would totally disappear. The green grounds by strong heat are made with the oxides of cobalt and nickel, but it is only a brownish green.

The bluish greens, named sky-blue, formerly a colour very much in esteem, can only be used on tender porcelain; they always scale off from hard porcelain, because there is potash in their composition. These greens cannot be used on glass because they afford a dirty colour: it is necessary to put a yellow on one side, and a more or less pale blue on the other, in order to produce a green. This colour may likewise be fabricated by mixing a blue with the yellow oxide of iron. Brougniart hoped to obtain a green from the oxide of chrome; and the experiments he made promised to be attended with success. The pure chromate of lead fixed on porcelain by means of a strong fire, afforded him a very deep and very fixed blue, of considerable beauty.

Concerning Bistres and Brown Reds.

These are obtained by mixtures of different proportions, of manganese, brown oxide of copper, and the oxide of iron, called umber. They are likewise previously fused in their solvents, so that they do not in the least change on tender porcelain; lead not having the same action on the oxide of manganese as it has on that of iron. This colour may be employed very well on glass.

The brown red, ground by strong heat, known by the name of *fonds caille*, are made in the same manner: feld-spar is their flux. There is no titanium in their composition, though generally asserted in books. Titanium was not known at Sévre when Brougniart first came to that manufactory. He treated this singular metal in various ways, and never obtained any grounds but a slight obscure yellow, and very uncertain in its quality.

Concerning the blacks.

Black colours are the most difficult to be obtained very beautiful. There is no metallic oxide which, singly, affords a fine black. Manganese gives the best; iron, an opaque, dull, blistered black, which easily turns to red. The makers of colours have therefore combined several metallic oxides which, singly, do not afford blacks, and they have obtained a very beautiful colour, but it is subject to scale and become dull.

The oxides are those of manganese, the brown oxides of copper, and a little of that of cobalt. Grey is obtained by suppressing the quantity of copper and increasing the quantity of flux.

The Sévres manufactory is the only one which has as yet produced beautiful blacks with a strong fire. This is more owing to the quality of the biscuit than to any peculiarity of process. It is by a mixture of blue with the oxides of manganese and iron that they make this very brilliant black.

The blacks for opaque glass are made the same as for painting, by giving different doses of solvent.

After the display of the principles of fabricating each principal colour, it is clear that by mixing these colours all possible shades may be obtained: and also that care in the preparation, choice of materials, and just proportions of doses, must exhibit very sensible differences to the experienced eye of a painter. A knowledge of the composition of colours does not give the requisite care and neatness in making them up.

On recapitulating the facts here just stated, in order to present them in a general view; we see, first, that amongst the colours usually employed for hard porcelain, one only is susceptible of change, namely, the carmine; and this may be replaced by the reds of iron, and then no colour changes.

M. Brougniart presented to the Institute an unbaked head made in this manner, and a painting of two roses, the one baked and the other in its first state. There was not any difference between them.

Secondly, That amongst the colours of soft porcelain and enamel, several change considerably, particularly the reds of iron

and gold, with the yellows, greens, and browns. None have been substituted instead of them, this species of painting being almost abandoned.

Thirdly, That several of these colours change likewise upon the glass by becoming perfectly transparent, particularly the yellows and violets.

Fourthly, That neither an additional calcination, nor an additional fusion, as has been suspected, will prevent them from changing: for this method alters the colours that change, and does nothing to the rest. The change which several colours undergo on tender porcelain, and on glass, does not therefore relate to the nature of their composition, but rather to that of the body on which they are placed. Consequently, by suppressing the carmine of gold from the colours of hard porcelain we shall have a series of unchangeable colours.

ENARGEA, in botany, a genus of the Hexandria Monogynia class and order. Essential character: calyx none; petals six, oblong, ovate, concave, acute, three outer, three inner, green spotted; berry three-celled, with four or five globular seeds. There is but one species, *viz.* E. marginata, a native of Terra del Fuego.

ENCALYPTA, in botany, a genus of the Cryptogamia Musci class and order. Capsule cylindrical; fringe simple, of sixteen linear erect distinct teeth; veil companulate, inflated lax. There are six species.

ENCAUSTIC, the same with enamelling and enamel. See ENAMELLING.

ENCAUSTIC *painting*, a method of painting made use of by the antients, in which wax was employed to give a gloss to their colours, and to preserve them from the injuries of the air.

ENCHASING, or CHASING, the art of enriching and beautifying gold, silver, and other metal work, by some design, or figures represented thereon, in low relievo. See RELIEVO and SCULPTURE.

Enchasing is practised only on hollow thin works, as watch-cases, cane-heads, tweezer-cases, or the like. It is performed by punching or driving out the metal, to form the figure, from within side, so as to stand out prominent from the plane or surface of the metal. In order to this they provide a number of fine steel blocks, or puncheons, of divers sizes; and the design being drawn on the surface of the metal, they apply the inside upon the heads or tops of these blocks, directly under the lines or parts of the figures; then with a fine hammer, striking on the metal, sustained by the block, the metal yields and the block makes an indenture or cavity on the inside, corresponding to which there is a prominence on the outside, which is to stand for that part of the figure.

Thus the workman proceeds to chase and finish all the parts by successive application of the block and hammer, to the several parts of the design. And it is wonderful to consider with what beauty and justness, by this simple piece of mechanism, the artists in this kind will represent foliages, grotesques, animals, histories, &c.

ENCHELIS, in natural history, a genus of the Vermes Infusoria. Worm invisible to the naked eye, very simple, cylindrical. There are fifteen species. An account of these may be found in Adams "On the Microscope."

ENCROACHMENT, in law, an unlawful gaining upon the rights or possessions of another. It is generally applied to the unlawful occupation of wastes and commons.

ENDEAVOUR, where one endeavours actually to commit felony, &c. he is punishable as for a misdemeanour; and an assault, with intent to rob, is punished by transportation. Stat. 7, Geo. II. c. 21.

ENDECAGON, a plane geometrical figure of eleven sides and eleven angles. If each side of this figure 1, its area will be $9.3656399 = \frac{11}{4}$ of the tangents of $73\frac{7}{11}$ degrees to the radius one.

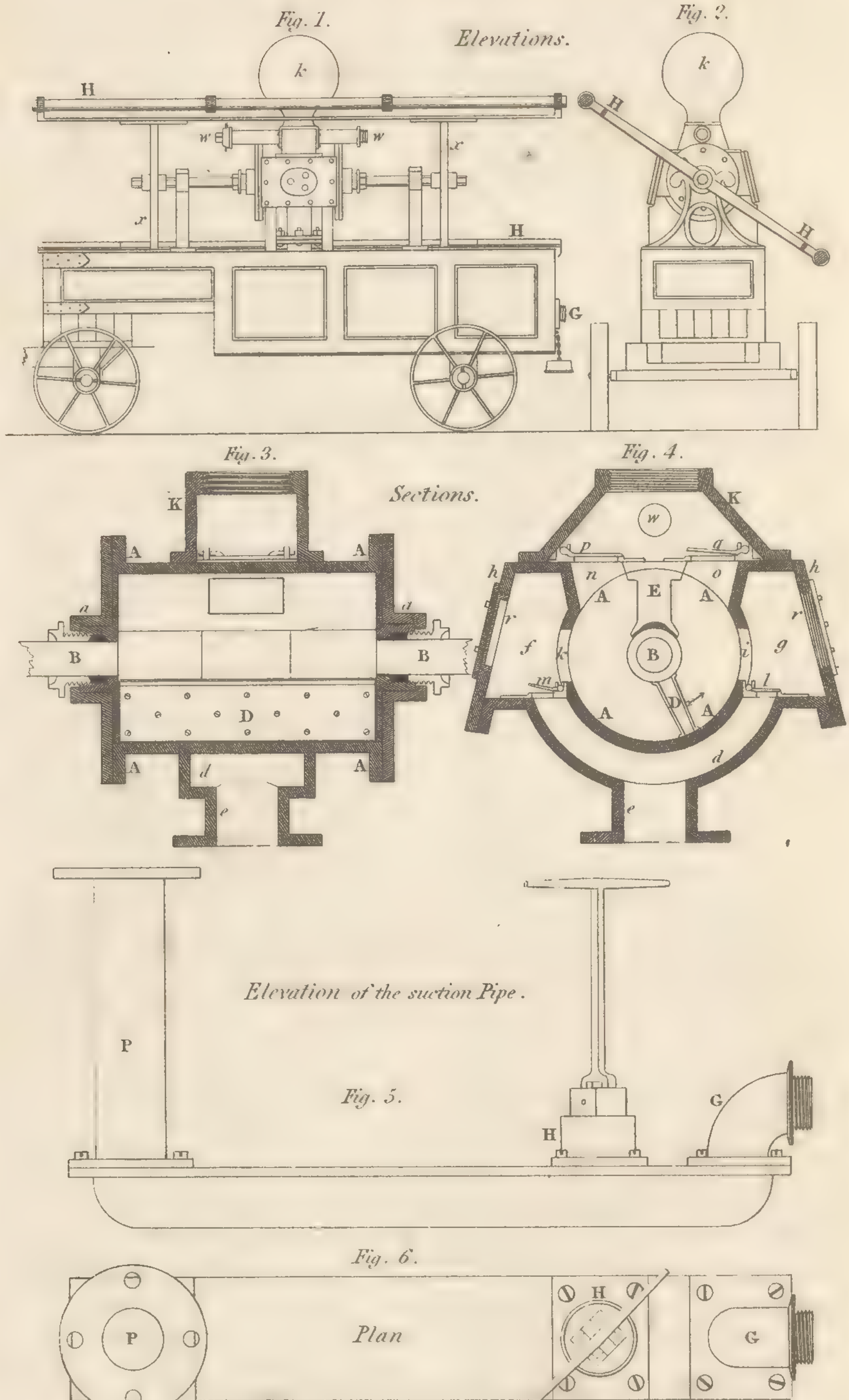
ENDEMIC, or ENDEMICAL *diseases*, those to which the inhabitants of particular countries are subject more than others, on account of the air, water, situation, and manner of living.

ENDIVE, in botany, &c. broad-leaved succory. See CICHORIUM.

ENDOWMENT, in law, is the widow's portion; being a third part of all the freehold lands and tenements, of which her husband was seized at any time during the coverture. Of lands not freehold, her portion varies according to the custom in different places.

ENEMY, in law, an alien or foreigner, who in a public capacity invades any country, and who cannot be punished as a traitor, but must be subjected to martial law. An alien residing here, under the protection of the king's peace, may be dealt with as a traitor, because he owes a qualified allegiance.

ROWNTREE'S FIRE ENGINE.



J. Farey Jun^r. delin.

Lowry sculp.

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ENFRANCHISEMENT, in law, the incorporating a person into any society or body politic; such as the enfranchisement of one made a citizen of London or other city, or burgess of any town corporate, because he is made partaker of its liberties, or franchises.

ENGINE, in mechanics, is a compound machine, made of one or more mechanical powers, as levers, pullies, screws, &c. in order to raise, cast, or sustain any weight, or produce any effect which could not be easily effected otherwise.

Engines are extremely numerous; some used in war, as the battering-ram, ballista, waggons, chariots, &c.; others in trade and manufactures, as cranes, mills, presses, &c.; others to measure time, as clocks, watches, &c.; and others for the illustration of some branch of science, as the orrery, cometarium, and the like.

In general we may observe, concerning engines, that they consist of one, two, or more of the simple powers variously combined together; that in most of them the axis in peritrochio, the lever, and the screw, are the constitutent parts; that in all a certain power is applied to produce an effect of much greater moment; and that the greatest effect or perfection is when it is set to work with four-ninths of that charge which is equivalent to the power, or will but just keep the machine in equilibrio.

In all machines the power will just sustain the weight, when they are in the inverse ratio of their distances from the centre of motion.

Engine, *fire*, by Rowntree. We have selected an engine by this maker to give a drawing and description, as it is greatly superior to the common engine with two force pumps. As that kind of engine has so often been described by various authors, and its principle so easily comprehended from the description of a force-pump; we judged it unnecessary to give any drawing of it.

The fire engine, by Rowntree, is a double force-pump, of a peculiar construction, similar in its action to the beer-engine (described under that article), but as it is on a much larger scale, its constructions are of course varied. Plate Rowntree's Engine, fig. 1 and 2, are two elevations at right angles to each other, of the external part of the engine mounted on four wheels. Fig. 3 and 4, are two sections perpendicular to each other, of the body of the engine or pump: fig. 5 and 6, are parts of the engine. The same letters are used as far as they apply in all the figures, A, A, A, A; fig. 3 and 4, is a cast-iron cylinder truly bored, it is ten inches diameter and fifteen long; it has a flanch at each end whereon to screw two covers, with stuffing boxes, *a*, *a*, in their centres, through which the spindle, B, B, of the engine passes, and being tight packed with hemp round the collar, makes a tight joint; the piston, D, is affixed to the spindle within the cylinder, and fits it tight all round by means of leathers, applied as described in the beer-engine; at E, fig. 4, a partition called a saddle, is fixed in the cylinder, and fits against the back of the spindle tight by a leather.

We have now a cylinder divided by the saddle, E, and piston, into two parts, whose capacity can be increased and diminished by moving the piston, with proper passages and valves to bring and convey away the water: this will form a pump. These passages are cast in one piece with the cylinder: one, *d*, for bringing the water is square, and extends about ⅓d round the cylinder; it connects at bottom with a pipe, *e*; at its two upper ends opens into two large chambers, *f g*, extending near the whole length of the cylinder, and closed by covers, *h h*, screwed on: *i k*, are square openings (shewn by dotted squares in fig. 3.) in the cylinder, communicating with the chambers: *f g*, *l m*, are two valves, closing their ends of the curved passage, *d*, and preventing any water returning down the passage, *d*: *n o*, are two passages from the top of the cylinder to convey away the water; they come out in the top of the cylinder, which, together with the top of the chambers, *f*,*g*, form a large flat surface, and are covered by two valves, *p*, *q*, to retain the water which has passed through them. A chamber, K, is screwed over these valves; and has the air-vessel, *k*, fig. 1 and 2, screwed into its top; from each side of this chamber a pipe, *w w*, proceeds, to which a hose is screwed, as shewn in fig. 1. Levers, *x x*, are fixed to the spindle at each end, as shewn in fig. 1, and carry the handles, H H, by which men work the engine. When the piston moves, as shewn by the arrow in fig. 4, it produced a vacuum in chamber, *f*, and that part of the cylinder contiguous to it; the water in the pipe, *e*, then opens the valve, *m*, and fills the cylinder. The same motion forces the water contained in the other part of the cylinder through the valve, *q*, into chamber, K, and thence to the hose through the pipe, *w*; the piston being turned the other way, reverses the operation with respect to the valves,

though it continues the same in itself. The pipe, *e*, is screwed by a flanch to an upright pipe, P, fig. 5, connected with another square iron pipe, fastened along the bottom of the chest of the engine; a curved brass tube, G, comes from this pipe through the end of the chest, and is cut into a screw to fit on the suction hose when it can be used; at other times a close cap is screwed on, and another brass cap at H, within the chest is screwed upwards on its socket, to open several small holes made in it, and allow the water to enter into the pipe; in this case the engine chest must be kept full of water by buckets. The valves are made of brass, and turn upon hinges. The principal advantage of the engine is the facility with which it is cleaned from any sand, gravel, or other obstructions, which a fire-engine will always gather when at work.

The chambers, *f, g*, being so large, allow sufficient room to lodge a greater quantity of dirt than is likely to be accumulated in the use of the engine at any one fire, and if any of it accidentally falls into the cylinder, it is gently lifted out again into the chambers by the piston, without being any obstruction to its motion: to clear the engine from the dirt, two circular plates, *r r*, five inches diameter, are unscrewed from the lids, *h h*, of the chambers, *f g*, and when cleaned are screwed on again: these screw covers fit perfectly tight without leather, and can be taken out, the engine cleared, and enclosed again in a very short time, even when the engine is in use, if found necessary.

The two upper valves, *p q*, and chamber, K, can also be cleared with equal ease, by screwing out the air-vessel, *k k*, fig. 1, which opens an aperture of five inches, and fits air-tight, without leather, when closed. The valves may be repaired through the same openings. The use of the air-vessel, *k k*, fig. 1 and 2, is to equalize the jet from the engine during the short intermittance of motion at the return of the piston stroke; this it does by the elasticity of the compressed air within it, which forces the water out continually, though not supplied quite regularly from the engine.

The engine from which our drawing was taken was made for the Sun Fire Insurance Company, in London, and from some experiments made by their agent, Mr. Samuel Hubert, appears to answer every purpose.

ENGINE *for raising water*. The frame of the machine is of cast iron, nearly in the form of the letter A; there are two of these frames, B B, (fig. 1, Plate Pump-Engine,) screwed together by means of five wrought iron pillars, *a a a a*; D, is another smaller frame, to support the axis of the fly-wheel, connected with the other frame by three short pillars; E, is the fly wheel turned by winches on the end of its axis; it has a pinion (13) of 13 leaves upon its axis, turning a wheel (48) of 48 teeth, on whose axis are two cranks, *b b*, opposite to each other, to work the pumps; *e e*, are the two crank rods, made each in two branches, and jointed at the lower end into two other rods, *f f*, which slide through holes made in the fixed bars, *g g*, fig. 2; the crank rods receive these bars between their two branches, and by this means, though the rods, *f f*, are confined by their guides to move truly vertical, the crank rods, *e e*, can partake of the irregular motion of the crank. The pump rods of the pumps are screwed to the rods, *f f*, by two nuts, and go down into the pumps, G H, supported from the iron frame by eight iron braces, *h h*. The pumps consist of two barrels, G H, with valves at the bottom, allowing water to enter them freely, but preventing its return; the buckets fixed to the pump rods fit the barrels truly, and have valves in them shutting downwards; I, is a chest bringing water to the valves in the bottom of the barrels; K, is another communicating with the top of the barrels by two crooked passages to carry away the water from them; the barrels are close at top, and the pump rods pass through close stuffing boxes, through which no water will leak by them. The action of the pump is the same as the common sucking pump; when the bucket is drawn up, the valve in it closes, and it forms a vacuum in the lower part of the barrel; this causes the water to ascend into it through the chest, I, to restore the equilibrium, at the same time it raises all the water which was above it through the chest, K; on the descent of the bucket the valve at the bottom of the barrel shuts, and prevents the escape of the water; the valve in the bucket opens, and the water passes through it, ready to be raised at the next stroke. The barrels in question are $3\frac{1}{2}$ inches diameter, and 8 inches stroke. As the two cranks, *b b*, are opposite each other, when one bucket is rising, the other is going down; by this means the power required to turn the machine by the handles is equalized, and also the quantity of water raised by the engine.

Engines for raising water by the pressure and descent of a column inclosed in a pipe

have been lately erected in different parts of the country. The principle now adverted to was adopted in some machinery executed in France about 1731, and was likewise adopted in Cornwall more than forty years ago; but the pressure engine, of which we are about to give a particular description, is the invention of Mr. R. Trevithick, who probably was not aware that any thing at all similar had been attempted before. This engine, a section of which on a scale of $\frac{1}{3}$d of an inch to a foot is shewn in Plate Pressure-Engines, one was erected about eight years ago at the Druid copper mine, in the parish of Illogan, near Truro. A B, represents a pipe six inches in diameter, through which water descends from the head to the place of its delivery to run off by an adit at S, through a fall of 34 fathoms in the whole; that is to say, in a close pipe down the slope of a hill 200 fathoms long, with 26 fathoms fall; then perpendicularly six fathoms, till it arrives at B, and thence through the engine from B to S two fathoms; at the turn, B, the water enters into a chamber, C, the lower part of which terminates in two brass cylinders, four inches in diameter; in which two plugs or pistons of lead, D and E, are capable of moving up and down by their piston rods, which pass through a close packing above, and are attached to the extremities of a chain leading over and properly attached to the wheel, Q, so that it cannot slip.

The leaden pieces, D and E, are cast in their places, and have no packing whatever. They move very easily; and if at any time they should become loose, they may be spread out by a few blows with a proper instrument, without taking them out of their place. On the side of the two brass cylinders, in which D and E move, there are square holes communicating towards, G, with a horizontal trunk, or square pipe, four inches wide, and three inches deep. All the other pipes, G, G, and R, are six inches in diameter, except the principal cylinder wherein the piston, H, moves; and this cylinder is ten inches in diameter, and admits a nine foot stroke.

The piston rod works through a stuffing-box above, and is attached to, M N, which is the pit rod, or a perpendicular piece divided into two, so as to allow its alternate motion up and down, and leave a space between, without touching the fixed apparatus, or great cylinder. The pit rod is prolonged down in the mine, where it is employed to work the pump; or if the engine was applied to mill-work, or any other use, this rod would be the communication of the first mover. K L, is a tumbler, or tumbling bob, capable of being moved on the gudgeons, V, from its present position to another, in which the weight, L, shall hang over with the same inclination on the opposite side of the perpendicular, and consequently the end, K, will then be as much depressed as it is now elevated.

The pipe, R S, has its lower end immersed in a cistern, by which means it delivers its water without the possibility of the external air introducing itself; so that it constitutes a Torricellian column, or water barometer, and renders the whole column from A to S effectual, as we shall see in our view of the operation.

The operation. Let us suppose the lower bar, K V, of the tumbler to be horizontal, and the rod, P O, so situated, as that the plugs, or leaden pistons, D and E, shall lie opposite to each other, and stop the water ways, G and F. In this state of the engine, though each of these pistons is pressed by a force equivalent to more than a thousand pounds, they will remain motionless, because these actions being contrary to each other, they are constantly in equilibrio. The great piston, H, being at the bottom of its cylinder, the tumbler is to be thrown by hand into the position here delineated. Its action upon, O P, and consequently upon the wheel, Q, draws up the plug E, and depresses D, so that the water way, F, becomes open from A B, and that of G to the pipe R: the water consequently descends from A to C, thence to F, until it acts above the piston F. This pressure forces down the piston, and if there be any water below the piston, it causes it to pass through G G G into R: during the fall of the piston, which carries the pit rod, M N, along with it, a sliding block of wood, I, (dotted) fixed to this rod is brought into contact with the tail, K, of the tumbler, and lowers it to the horizontal position beyond which it oversets by the acquired motion of the weight L.

The mere rising of the piston, if there was no additional motion in the tumbler, would only bring the two plugs, D and E, to the position of rest, namely, to close G and F, and then the engine would stop; but the fall of the tumbler carries the plug, D, upwards, quite clear of the hole, F, and the other plug, E, downwards, quite clear of the hole, G: these motions require no consumption of power, because the plugs are in equilibrio, as was just observed. In this new situation the column, A B, no longer

communicates with F, but acts through G upon the lower part of the piston H, and raises it; while the contents of the great cylinder above that piston are driven out through F, and pass through the opening at D into R. It may be observed, that the column which acts against the piston is assisted by the pressure of the atmosphere, rendered active by the column of water hanging in R, to which that assisting pressure is equivalent, as has already been noticed. When the piston has ascended through a certain length, another slide or block upon the pit-rod (not seen) applies against the tail, K, of the tumbler, which it raises and again oversets, producing once more the position of the plugs, D E, here delineated, and the consequent descent of the great piston, H, as before described. The descent produced the former effect on the tumbler and plugs, and in this manner it is evident that the alternations will go on without limit, or until the manager shall think fit to place the tumbler and plugs, D E, in the positions of rest, namely, so as to stop the passages, F and G. The length of the stroke may be varied by altering the positions of the pieces, I, and the other lower down, which will shorten the stroke, the nearer they are together; as in that case they will sooner alternate upon the tail, K. As the sudden stoppage of the descent of the column, A B, at the instant when the two plugs were both in the waterway might jar and shake the apparatus, those plugs are made half an inch shorter than the depth of the side holes, so that in that case the water can escape directly through both the small cylinders to R. This gives a moment of time for the generation of the contrary motion in the piston, and the water in G G G, and greatly deadens the concussion which might else be produced. See STEAM ENGINE.

Some former attempts to make pressure engines upon the principle of the steam-engine have failed; because water not being elastic, could not be made to carry the piston onwards a little, so as completely to shut one set of valves and open another; in the present judicious construction the tumbler performs the office of the expansive force of steam at the end of the stroke.

ENGINE *for driving piles*, used at building Westminster bridge, is constructed as follows: A, (Plate V. Miscel. fig. 3.) is the great shaft, on which are the great wheel and drum: B, the great wheel with cogs, that turns a trundle head with a fly, to prevent the horse's falling when the ram is discharged; C, the drum on which the great rope is wound; D, the follower (with a roller at one corner) in which are contained the tongs, to take hold of the ram, and are fastened to the other end of the great rope which passes over the pulley, near the upper end of the guides between which the ram falls; E, the inclined planes, which serve to open the tongs, and discharge the ram; F, the spiral barrel that is fixed to the drum, on which is wound a rope with a counterpoise, to hinder the follower from accelerating, when it falls down to take up the ram; G, the great bolt which locks the drum to the great wheel; H, the small lever, which has a weight fixed at one end, passes through the great shaft below the great wheel, and always tends to push the great bolt upwards, and lock the drum to the great wheel; I, the forcing bar, which passes through the hollow axis of the great shaft, bears upon the small lever, and has near the upper end a catch by which the crooked lever keeps it down; K, the great lever, which presses down the forcing bar, and discharges the great bolt at the time the long end is lifted up by the follower; L, the crooked lever, one end of which has a roller, that is pressed upon by the great rope, the other end bears upon the catch of the forcing bar during the time the follower is descending; M, the spring that presses against the crooked lever, and discharges it from the catch of the forcing bar as soon as the great rope slackens and gives liberty to the small lever to push up the bolt.

By the horse's going round, the great rope is wound about the drum, and the ram is drawn up, till the tongs come between the inclined planes, where they are opened, and the ram is discharged.

Immediately after the ram is discharged, the roller, which is at one end of the follower, takes hold of the rope that is fastened to the long end of the great lever, and lifts it up; the other end presses down the forcing bar, unlocks the drum, and the follower comes down by its own weight.

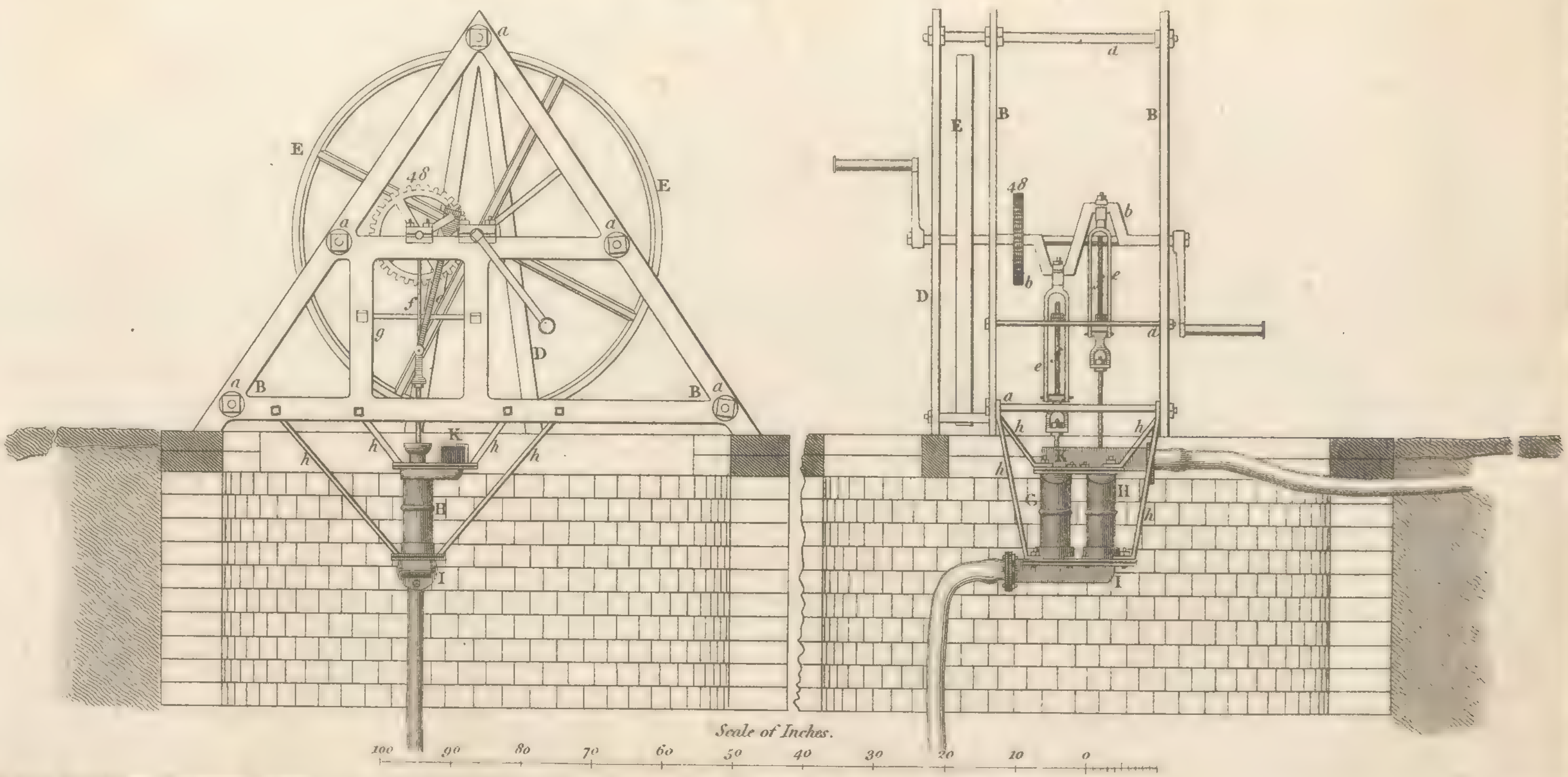
As soon as the follower touches the ram, the great rope slackens, and the spring, M, discharges the crooked lever from the catch of the forcing bar, and gives liberty to the small lever to push up the great bolt, and to lock the drum to the great wheel, and the ram is drawn up again as before.

ENGINEER, in the military art, an able, expert man, who by a perfect knowledge in mathematics, delineates upon pa-

A double Barreled Hand Pump Engine, by M^r. Rowntree.

Fig. 2.

Fig. 1.



Scale of Inches.

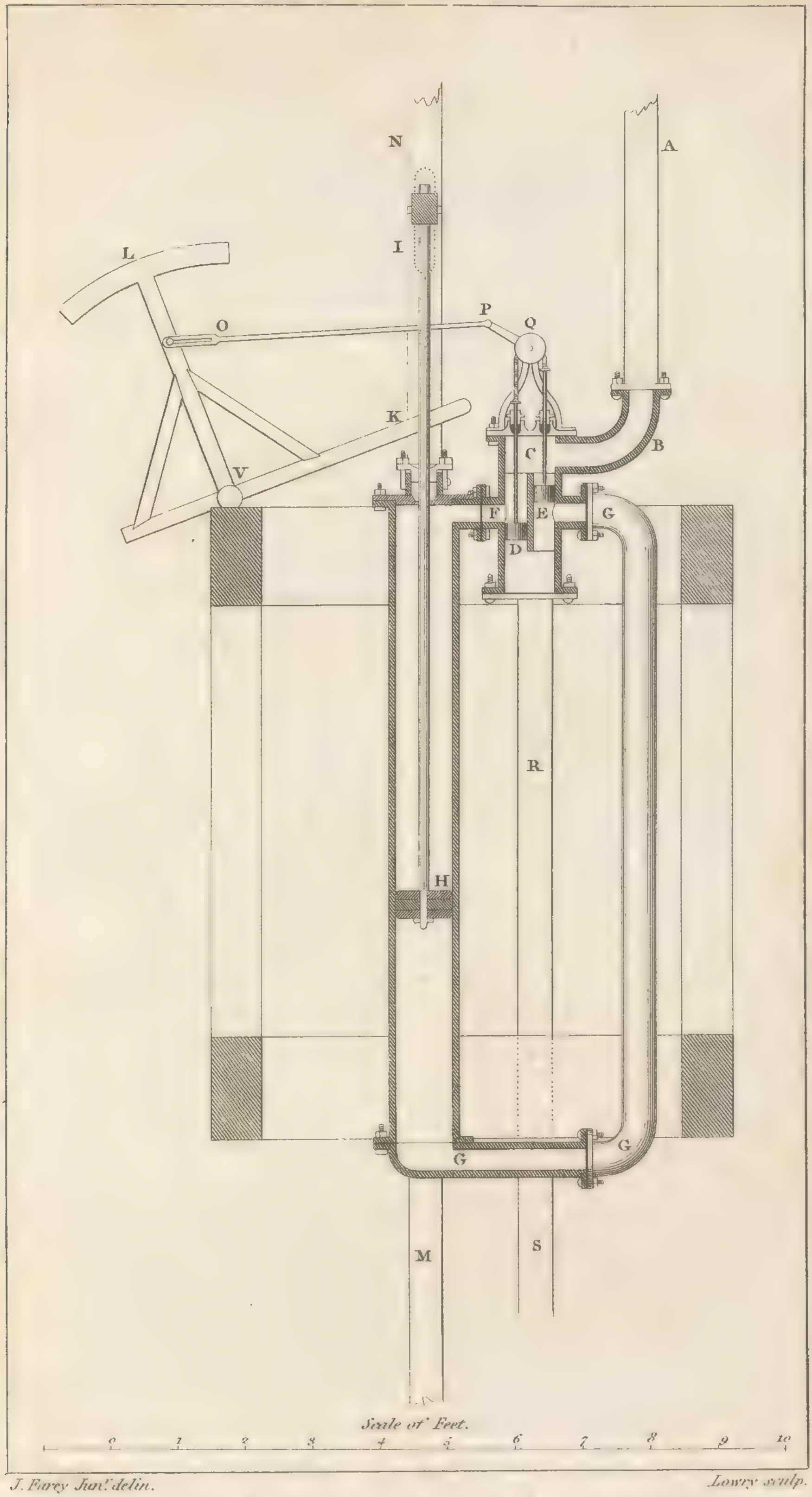
100 90 80 70 60 50 40 30 20 10 0

J. Farey Jun^r. delin.

Lowry, sculp.

London. Published by Longman, Hurst, Rees & Orme, May 1, 1808.

Mr R. TREVATHICK'S PRESSURE ENGINE,
erected at the Druid Copper Mine, Cornwall.



J. Farey Junr. delin. Lowry sculp.

London, Published by Longman, Hurst, Rees & Orme, 1808.

per, or marks upon the ground, all sorts of forts, and other works proper for offence and defence. He should understand the art of fortification, so as to be able, not only to discover the defects of a place, but to find a remedy proper for them, as also how to make an attack upon, as well as to defend the place. Engineers are extremely necessary for these purposes: wherefore it is requisite that, besides being ingenious, they should be brave in proportion. When at a siege the engineers have narrowly surveyed the place, they are to make their report to the general, by acquainting him which part they judge the weakest, and where approaches may be made with most success. Their business is also to delineate the lines of circumvallation and contravallation, taking all the advantages of the ground; to mark out the trenches, places of arms, batteries, and lodgments, taking care that none of their works be flanked or discovered from the place. After making a faithful report to the general of what is a doing, the engineers are to demand a sufficient number of workmen and utensils, and whatever else is necessary.

ENGRAFTING, or GRAFTING, in gardening. See the article GRAFTING.

ENGRAILED, or INGRAILED, in heraldry, a term derived from the French, hail; and signifying a thing the hail has fallen upon and broke off the edges, leaving them ragged, or with half rounds, or semicircles, struck out of their edges.

ENGRAVING. This term is at present confined to the art of excavating copper and wood, in lines, in so judicious a manner as to produce imitations of paintings and drawings when printed on paper. It is certain that engraving for the production of prints was unknown long after the practice of painting in oil had arrived to great perfection, but good prints are common from plates engraved in the fifteenth century, many of which are landscapes most laboriously, and even excellently performed by the graver, although it is well known that the instrument just mentioned cannot freely express those serrated and serpentine lines necessary for foliage and short grass intermixed with plants, since so admirably delineated in etchings. A goldsmith of Florence, named Maso Finiguerra, is said to have discovered the art; but this assertion must undoubtedly merely apply to his obtaining impressions from lines engraved originally without the least idea of such a result: were we to examine the subject closely, it might be proved, that outlines have been cut in metals, representing figures, &c. from the most remote periods of antiquity, but being subject to decay, they have not reached our time as the more durable granites have done, embellished with hieroglyphics cut in them in a manner which might be printed on paper. Arguing from these premises, it may be inferred, that the antients understood the art of engraving in metal, though without conceiving that the copies of their productions might be multiplied by means of ink on soft white cloth, or similar materials. Albert Durer, born in 1470, and who died at Nuremberg 1528, is said to have been the first person on record claiming the name of an engraver in the long list of celebrated artists; but certainly very excellent engraved brass figures, the lines filled with substances to show them more clearly, are now extant on tombs in some hundreds of churches in England, the dates of many of which are prior to the time of his birth. This fact will serve to prove that the *printing* of engraved plates was discovered between 1470 and 1528; indeed the perfection that engraving had reached in the latter century, plainly demonstrates that the use of the graver was by no means a modern discovery. The encouragement of the fine arts has ever been a distinguishing trait of the inhabitants of the continent of Europe; it is not wonderful, therefore, that engraving closely followed the footsteps of the parent arts, and flourished there in greater perfection than in England, where they have been in a state of miserable depression till within the last century, when literature was supposed to receive some aid from the graver, the booksellers taking the hint, have encouraged the predilection of the public, which has operated as a stimulus to the artist, and the consequence is, that the graphic embellishments of British topographical and poetical works are equal, if not superior, to any in Europe.

Historical engravings for the port folio and furniture seemed at one period to advance rapidly towards perfection, to which the late Alderman Boydell greatly contributed; but the death of Strange, Hall, and Woollet, have been almost fatal to the hopes of the amateur, which rest, in a great measure, upon Heath, Sharp, Bromley, and a few others, as in this particular instance we do not include those eminent foreigners who have, or do at present reside in England. Whatever deficiencies we may

discover in the prosecution of the arts in this country, is fortunately not to be attributed to want of genius, or relaxation from study in the artist; the chill of apathy in the rich, who view a wretched coloured aquatint with the same or more pleasure than the most laboured production of the graver, is the baleful cause of the languishing state of historical engraving. When persons capable of affording patronage are taught discrimination, future Woollets will fascinate the best judges of engraving.

We shall now proceed to explain the methods of executing different descriptions of engraving. The graver, an instrument of steel, is the primary object for engraving on copper; it is square for cutting of broad lines, and lozenge for the finest, and must be tempered to that exact state which will prevent the point from breaking or wearing by its action on the metal; to obtain this state, it is customary to heat it when too hard on the end of a red hot poker, till it assumes a straw colour, and then cool it in oil; if held too long, it will become blue, soft, and useless, till the process of tempering the steel is renewed. As it is possible a graver may be of the proper degree of solidity, except in some inconsiderable part, it would be well to rub it on the oil stone till that is ascertained. The graver is inserted in a handle of hard wood, resembling a pear with a longitudinal slice cut off, which is to enable the artist to use it as flat on the plate as his fingers and thumb will permit. In order to prepare this instrument for cutting a clear smooth line, great care must be taken in sharpening it, that the original general form should be preserved, by laying the sides flat upon the oil-stone, and rubbing them so as not to round them in the least, after which the graver is to be held sloping towards the person, and rubbed thus till the point is extremely sharp; besides these precautions, it will be necessary that the point should not be exactly in a right line with the lower part of the graver, but a little higher, that it may not press too deep into the copper. In rubbing the sides of the graver, the usual manner has been to confine the right arm close to the side, placing the fore finger of the left hand on the upper side of the tool when on the stone. This instrument is used for finishing the imperfections discoverable in etchings, and exclusively in engraving writing.

The scraper is a long triangular piece of steel, tapering gradually from the handle to the point; the three edges produced by this form, being sharpened on the oil-stone, are used for scraping off the roughness occasioned by the graver, and erasing erroneous lines.

The burnisher is a third instrument of steel, hard, round, and highly polished, for rubbing out punctures or scratches in the copper. The oil-stone has been already mentioned, to those may be added the needle or dry point for etching, and making those extremely fine lines which cannot be done with the graver.

Cushions made of soft leather, and filled with fine sand, hence called sand-bags, are required for the support of the plate in engraving, which, from their circular surface, permits the copper to turn with ease, and facilitates the cutting of those true curves composing the shading of most subjects. The oil rubber and charcoal are necessary for polishing the plate.

Every thing depends upon the free use of the graver, therefore the utmost care must be taken to hold it properly, by preventing the interposition of the fingers between the graver and the plate, with the fore finger on the upper angle, which enables the artist to conduct it parallel with the substance engraved, thus preventing the point from entering deeply, and impeding the progress of the tool.

To engrave well requires good materials, though those are nearly confined to two, the graver, and the best copper, the latter should be free from flaws, small punctures, well hammered to close the pores, and polished to such a degree as to be free from the slightest scratches.

To trace the design intended for engraving accurately on the plate, it is usual to heat the latter sufficiently to melt white wax, with which it must be covered equally and thin, and suffered to cool; the drawing is then copied in outlines with a black-lead pencil on paper, which is laid with the pencilled side upon the wax, and the back rubbed gently with the burnisher, which will transfer the lead to the wax. The design must next be traced with an etching needle through the wax on the copper, when, on wiping it clean, it will exhibit all the outlines ready for the graver.

The table intended for engraving on should be perfectly steady, and the sand-bags placed equally firm; in cutting of curved or undulating lines, the graver must be held still, or moved, to suit the turning of the plate with the left hand, but when straight lines are intended, the plate is to be held stationary, and the graver urged

forward with more or less pressure, according to the thickness of the line. Great care is necessary to carry the hand with such steadiness and skill as to prevent the end of the line from being stronger and deeper than the commencement; and sufficient space must be left between the lines to enable the artist to make those stronger, gradually, which require it. The roughness or burr occasioned by the graver must be removed by the scraper, the lines filled by the oil-rubber, and the surface of the copper cleansed, in order that the progress of the work may be ascertained.

If any accident should occur by the slipping of the graver beyond the boundary required, or lines are found to be placed erroneously, they are to be effaced by the burnisher, which leaving deep indentings, those must be levelled by the scraper, rubbed with charcoal and water, and finally polished lightly with the burnisher.

As the uninterrupted light of the day causes a glare upon the surface of the copper, hurtful and dazzling to the eyes, it is customary to engrave beneath the shade of silk paper, stretched on a square frame, which is placed reclining towards the room near the sill of a window.

Such are the directions and means to be employed in engraving historical subjects; indeed the graver is equally necessary for the completion of imperfections in etching, to which must be added the use of the dry point in both, for making the faintest shades in the sky, architecture, drapery, water, &c. &c.

Engraving of Mezzotintos differs entirely from the manner above described; this method of producing prints, which resemble drawings in Indian ink, is said by Evelyn, in his history of chalcography, to have been discovered by Prince Rupert, and was some years past a very favourite way of engraving portraits and historical subjects; of the former, the large heads by Fry are of superior excellence.

The tools required for this easy and rapid mode of proceeding, are the grounding-tool, the scraper, and the burnisher; the copper-plate should be prepared as if intended for the graver, and laid flat upon a table, with a piece of flannel spread under it to prevent the plate from slipping; the grounding-tool is then held perpendicularly on it, and rocked with moderate pressure backwards and forwards, till the teeth of the tool have equally and regularly marked the copper from side to side, the operation is afterwards repeated from end to end, and from each corner to the opposite; but it is necessary to observe, that the tool must never be permitted to cut twice in the same place; by this means the surface is converted into a rough chaos of intersections, which, if covered with ink and printed, would present a perfectly black impression upon the paper.

To transfer the design to be scraped, it is usual to rub the rough side of the plate with a rag dipped into the scrapings of black chalk, or to smoke it with burning wax taper, as in the process for etching; the back of the design is then covered with a mixture of powdered red chalk and flake white, and laid on the plate through which it is traced; particles of red, in the form of the outlines, are thus conveyed to the black chalk on the plate, which are to be secured there by the marks of a blunted point; the process must then be carried on with the scraper, by restoring the plate in the perfectly light parts of the intended print to a smooth surface, from which the gradations are preserved by scraping off more or less of the rough ground; but the burnisher is necessary to polish the extreme edges of drapery, &c., where the free touch of the brush in painting represents a brilliant spot of light. The deepest shades are sometimes etched and corroded by aqua fortis, and so blended with the mezzotinto ground added afterwards, that there is nothing offensive to the eye in the combination.

Many proofs are required to ascertain whether the scraping approaches the desired effect, which is done by touching the deficient parts with white or black chalk, on one of the proofs from the original drawing, and then endeavouring to make the plate similar by further scraping, or re-laying the ground with a small tool made for this particular purpose, where too much of the roughness has been effaced.

Engraving on Steel is confined to the cutting of punches, for the conveyance of any form a certain depth into that or any other metal, seals, and dyes, for impressing the designs of coins, medals, &c. on gold, silver, or copper, &c. The punches are engraved from models in wax made in relievo, and when completed, are tempered to that degree of solidity which will bear the violent blows without blunting the finest parts or breaking them, necessary to produce the matrix in the steel intended for striking of medals or coins, which must be heated to prevent such a disaster, and tempered

again, for a similar reason to the preceding, after it is finished.

There are several tools used in finishing of dyes, which are gravers, chissels, and flatters, and many little punches for making ornamental borders and mouldings to coins and medals; the latter are always in greater relief than the former, and consequently more difficult to execute in perfection.

Engraving on precious Stones is accomplished with the diamond or emery. The diamond possesses the peculiar property of resisting every body in nature, and, though the hardest of all stones, it may be cut by a part of itself, and polished by its own particles. In order to render this splendid substance fit to perform the operations of the tool, two rough diamonds are cemented fast to the ends of the same number of sticks, and rubbed together till the form is obtained for which they are intended; the powder thus produced is preserved, and used for polishing them in a kind of mill furnished with a wheel of iron; the diamond is then secured in a brazen dish, and the dust mixed with olive oil applied, the wheel is set in motion, and the friction occasions the polished surface so necessary to give their lustre due effect. Other stones, as rubies, topazes, and sapphires, are cut into various angles on a wheel of copper, and the material for polishing those is tripoli diluted with water.

A leaden wheel, covered with emery mixed with water, is preferred for the cutting of emeralds, amethysts, hyacinths, agates, granites, &c. &c. and they are polished on a pewter wheel with tripoli; opal, lapis lazuli, &c. are polished on a wheel made of wood.

Contrary to the method used by persons who turn metals, in which the substance to be wrought is fixed in the lathe, turned by it, and the tool held to the substance, the engraver of chrystal, lapis lazuli, &c. fixes his tools in the lathe and holds the precious stone to them, thus forming vases, or any other shape, by interposing diamond dust mixed with oil, or emery and water, between the tool and the substance as often as it is dispersed by the rotary motion of the former.

The engraving of armorial bearings, single figures, devices, &c. on any of the above stones after they are polished, is performed through the means of a small iron wheel, the ends of the axis of which are received within two pieces of iron, in a perpendicular position, that may be closed, or otherwise, as the operation requires; the tools are fixed to one end of the axis and screwed firm, the stone to be engraved is then held to the tool, the wheel set in motion by the foot, and the figure gradually formed. The materials of which the tools are made is generally iron, and sometimes brass, they are flat, like chissels, gouges, ferules, and others have circular heads. After the work is finished the polishing is done with hair brushes, fixed on wheels, and tripoli.

Engraving on Wood has been practised for several centuries, and originally with tolerable success, it languished for great part of the 18th century, but revived towards the close, and is still practised in a manner which reflects credit on the ingenuity of the age. Bewick will long be remembered by his works in this style of engraving, and his imitators have been numerous and successful. As it is entirely different from engraving on copper, the artist already acquainted with that mode would find himself at a loss how to proceed on wood, as the lines, instead of being cut into the substance, are raised like the letters of printing types, and printed in the same manner.

The wood used for this purpose is box, which is preferred for the hardness and closeness of its texture; the surface must be planed smooth and the design drawn on it with a black-lead pencil, the graver is then used, the finer excavations from which are intended for white interstices between the black lines produced by leaving the box untouched, and the greatest lights are made by cutting away the wood entirely of the intended form, length, and breadth; but the deepest shades require no engraving. Much of the beauty of this kind of engraving depends upon the printing, nor is it every artist who can excel in it, as expedition and freedom are not to be attained; in short, the best wooden cuts are evidently the products rather of perseverance and ingenuity than easy confidence in ability, observable in every line of fine etchings. There are some who succeed to admiration in representing foliage and plants, but unfortunately a few months practice will enable a pupil to etch them on copper with greater truth: drapery and architecture may be well done in wood, but the faces and limbs of figures never look well.

Such are the different descriptions of engraving which do not require the aid of

aqua fortis, of those made by the intervention of that liquid the principal is *Etching*, he that would excel in this branch of the arts must be thoroughly acquainted with drawing, otherwise his works will appear tasteless indeed. The ground used in etching is a combination of asphaltum, gum-mastick, and virgin wax, mixed in such proportions as will prevent the asphaltum from breaking the composition when under the aqua fortis, or the wax from making it so soft as to close the lines when cut through it by the needle. As every thing depends upon the stability of the ground, it should be purchased of those persons who are most celebrated for making it; or if the person wishing to use it prefers doing it himself, let him remember that he must keep every particle of grease or oil far from him and his materials, and that without the greatest care the inflammability of the asphaltum will ruin his operations in melting them. The proportions of the ingredients should be obtained by experiment.

After being prepared in the above manner the ground is tied in a piece of lustring for use, and another piece of the same kind of silk must be made into a dabber by tying a quantity of cotton in it. The copper-plate, hammered to a considerable degree of hardness, polished as if intended for the graver, and perfectly cleansed with whiting, is then secured at one corner by a hand vice, heated over a charcoal fire, and the silk containing the ground rubbed over it till every part is covered by the melted composition; but before it cools the silk dabber must be applied in all directions, till the surface of the plate is thinly and equally varnished. After this part of the process is completed, several lengths of wax taper, twisted together, are to be lighted, the plate raised by the vice in the left hand, and the right holding the burning taper is to be moved gently backwards and forwards under the ground, carefully avoiding touching it with the wick, yet causing the flame to spread over the surface, which will render it perfectly black, smooth, and shining, in a short time; this is to be ascertained by turning the plate: if the copper appears through the ground, the taper must be applied again immediately; but if it is held too long beneath the plate, the ground will become opaque, and break when the aqua fortis is used.

The next object is to transfer the design to the ground, which may be done by drawing it on thin white paper with a black lead pencil, and having it passed through the copper-plate printers' rolling press, who will accomplish it by laying the plate carefully on the board of his press, the pencilled paper slightly damped on it, and turning the press the lead will be conveyed firmly to the ground, which will appear in perfect outlines on removing the paper. Another method is to draw the design reversed from the original; rub the back with powdered white chalk, and laying it on the ground trace the lines through with a blunt point; this operation requires much precaution or the point will cut the ground; besides, if the paper is not securely fastened with wax at the corners it may slip, and either interrupt the true continuation of lines, or scratch the ground.

In working with the etching needle nothing more is required than to keep it upright, that the lines made by it through the ground may not slope, and thus make the aqua fortis corrode improperly; but it should be particularly observed, that the point, though taper, must be so rounded as to be free from a possibility of its tearing the surface of the copper, which would prevent the progress of the point, and ruin the plate when bitten; the necessary polish of the point may be accomplished by rubbing it on the sole of a shoe. The young artist must now be left to his own exertions, as directions for etching beyond those already given are useless, and he will acquire more knowledge and freedom from copying good prints in one week than a quarto volume of observations would afford. It seems almost needless to add, that every line must be kept distinct, at all events, throughout the plate, and that the most distant should be closer and more regular than those in the fore ground, as the greater the depth of shade the broader and deeper must the lines be made.

When the etching of the plate is completely finished, the edges of it must be surrounded by a high border of wax, so well secured that water will not penetrate between the plate and it. The best spirits of nitre fortis must then be diluted with water, in the proportion of one part of the former to four of the latter, which will be found to answer the first operations, if the weather is fine and the atmosphere free from moisture; but, if the contrary is the case, the spirits of nitre must be increased in proportion to the humidity of the air; this, when poured on the plate, cannot be too attentively observed in order to remove the bubbles of fixed air with a feather, and to ascertain the time for

stopping out the lightest parts; for it must be remembered the whole secret of biting or corroding any subject consists in the judicious manner in which the depth and breadth of the lines are varied, as by proper management they may be left scarcely perceptible, or increased very considerably. The composition used for the above purpose is, turpentine varnish mixed with lamp-black, and diluted so as to be used freely with a camel's hair pencil; this applied to the parts of the plate sufficiently corroded, will effectually prevent the aqua fortis from touching it again, and the remainder proceeds as if no such application had taken place: it will be necessary to strengthen the water as the work becomes nearer completion, but cautiously, lest the ground should be broken; and every time the aqua fortis is removed the plate must be washed with clean water and gradually dried, otherwise the varnish cannot be used, and the lines would be clogged with the decomposed metal. For taking the ground from the plate it is usual to cover the surface with olive oil, and heating it, wipe the plate with a soft piece of old linen and spirits of turpentine, will effectually remove all remaining dirt.

Re-biting, is the art of strengthening those lines of an etching in a plate from which the original ground has been cleansed. This is done by applying the ground as at first directed, but with great care that the melted composition does not fill, or even partially fill the lines, to prevent which the cotton wrapt in silk, called the dabber, should be used exclusively by taking a small quantity of melted ground on it, and gently touching the parts between the lines till they are equally and completely covered; if the plate is considerably heated, the ground will spread with more facility over the various interrupted surfaces. Carelessness or inattention will instantly ruin this process, and the whole of the plate: a border of wax must surround the parts to be rebitten, and a channel made to carry off the aqua fortis without injuring those already completed. Supposing the operations of etching and biting the plate entirely finished, nothing more remains than to examine it attentively, and improve it with the graver and dry point.

Stipling, or engraving in the dotted manner, was in a great measure introduced by Bartolozzi, whose works in this way are astonishingly numerous, exclusive of those to which his name is affixed and not the products of himself. Some pastoral scenes, with figures, when printed in colours have a pleasing effect; and small portraits stipled will bear examination; but historical subjects, which have great breadth of shade, appear to no advantage engraved in this manner. Stipling is performed by etching the plate with dots and biting it, laying the shades with a tool for the purpose, using the graver and the dry point, and scraping off the roughness thus occasioned.

Engraving in Aquatinta. The print from an aqua-tinted plate resembles a neatly finished drawing in Indian ink; this effect is produced by corroding the plate between the particles of a material entirely different from the etching ground. The first step in this process is to prepare a plate exactly in the way already described, and etch the outlines of the subject to be aqua-tinted, which are to be slightly bitten, and the plate thoroughly cleansed. The substance used to form the grains of the subject (which may be common resin, burgundy-pitch, asphaltum, gum-mastich, or gum-copal, either separate or mixed) should be reduced to a fine powder and sifted, put into a piece of muslin, and holding it high above the plate it must be struck against any substance held in the left hand till the shower of dust thus produced has covered the plate equally throughout, preserving it carefully in this situation, the plate is to be heated sufficiently to melt the powder, which will make the grains assume a circular form, and contract, leaving, when cold, a beautiful surface fit for the aqua fortis. Common resin is generally preferred for this part of the operation, but gum-copal is less liable to be broken loose from the plate during the process of biting.

The drawing to be copied must serve as the future basis of proceeding, which is to be imitated in the following manner: the perfectly white parts of the intended print are to be covered on the plate, with the varnish mentioned in etching, by the use of a camel's-hair pencil; a border of wax must then be raised, and the aqua fortis diluted poured on; the same method is afterwards practised in the stopping out before recommended, except that the depth of the corroding cannot be so great as in the line manner.

In order to obviate any difficulties which occur in procuring sufficient depths of shade, a method has been invented that enables the artist to produce an effect almost equal to the decisive touches of a brush filled with colour in drawing, which is the use of a liquid made with water, treacle,

or sugar, and fine washed whiting, exactly of the consistence of Indian ink, and laid on the granulated surface with a pencil, in the same free manner adopted on paper; after the above composition is thoroughly dry, the whole plate must be covered with a thin, weak, varnish of mastich, turpentine, or asphaltum, and when dried a second time, the aqua fortis is to be applied, which immediately breaking the varnish and whiting, will corrode the plate precisely in the marks of the pencil. The border of wax may be removed by heating the plate gently, and the ground varnish, &c. by oil of turpentine; a little fine whiting and a clean rag will then render the plate fit for the printer.

As the manner of procuring the grain by heating the powdered substance scattered over the plate is liable to objections, on account of the difficulty of making the particles assume the desired coarseness, or the reverse, and the engraving so produced rapidly wearing out in the printing, another has been contrived far more certain and satisfactory. In this mode, common resin, mastich, or Burgundy pitch, is dissolved in highly rectified spirits of wine of the best quality, each of which produce different descriptions of grains; but these substances may be mixed in such proportions as the artist prefers, and he must recollect that the resin makes the coarsest: to satisfy himself in this particular, the grain of every proportion should be tried on useless pieces of copper. Having a solution to his mind, it must remain undisturbed till every impure particle has subsided. The plate, polished and cleansed with whiting, is then placed to receive the liquid, which being poured on it, is held slanting till the most fluid parts has run off; it is afterwards laid to dry, in the progress of which the resin granulates, and adheres firmly to the surface. The greatest precaution must be used in going through this process, as the interposition of dust, grease, hairs, or fibres of linen, will cause total derangement, and even then it is subject to most vexatious uncertainty, often compelling the experienced artist to renew it to obtain a good grain; in short, the weather and untoward accidents frequently ruin his labours, though guarded against by every method his invention suggests. There is one advantage attending the pouring the liquid off, which is, that the heaviest particles of the resin will float to the lower side, and consequently leave a coarser grain there than above, much better suited to the deep shades of a landscape than if the granulations had been equally fine; in large subjects the grain is sometimes laid coarse purposely in the parts requiring it.

Although a fine grain has a very pleasing effect, and will bear close examination, it has several disadvantages; for this reason a medium description of granulation is preferable, which admitting the aqua fortis freely to the copper, it bites deeper, and is less apt by acting laterally to force off the resin, besides, the plate will of course afford a greater number of impressions.

Some hints have been given already for biting the plate; but however useful those may be found in particular instances, there are others which can only be extracted from close application and experiment, and those are often varied in their results: as an illustration, we may suppose an artist provided with several pieces of copper granulated, and trying each successively by his watch with spirits of nitre diluted to the state of the air at the commencement of his operations, how many minutes is necessary to produce one tint, how many for a second, &c. granting him two hours for his experiment; during this interval a violent shower of rain may occur, which will immediately affect the acid by weakening its properties in the same proportion as salt is observed to be dissolved by a humid atmosphere: thus it appears, a result obtained on a clear dry day will not suit a rainy one, and *vice versa.*

In opposition to this discouraging uncertainty, and in opposition to the judgment and preference of all true connoisseurs, aquatinted prints seem to increase in value in the estimation of many persons, who forget that national taste should be improved by works of superior execution, and not vitiated by being constantly familiarized to those produced by means which set genius at defiance.

ENNEAGON, in geometry, a polygon with nine sides. If each side be 1, the area will be 6, 18, &c.

ENNEANDRIA, the name of the ninth class in Linnæus's sexual system, consisting of plants which have hermaphrodite flowers, with nine stamina or male organs. The orders, or secondary divisions, in this class are three, being founded on the number of the styles, seed buds, or female organs. Laurus, tinus, and cassytha, have one style; rhubarb (rheum), has a triple stigma or summit, but scarce any style; flowering rush has six styles. The genera just enumerated are all that belong to the

class Enneandria. The first genus, laurus, is very extensive; comprehending the bay-tree, cinnamon tree, camphor tree, benjamin tree, sassafras tree, and the avocado or avogato pear.

ENS *martis*, an old name given by chemists to sal ammoniac sublimed with iron filings, and therefore consisting of muriate of ammonia mixed with a little muriate of iron.

Ens *veneris*, a similar preparation, in which copper filings are substituted for those of iron.

ENSATÆ, (from *enses*, a sword), the name of the sixth order in Linnæus's Fragments of a Natural Method, consisting of plants with sword-shaped leaves.

ENSIFORM, in general, something resembling a sword, *ensis*: thus we find mention of ensiform leaves, ensiform cartilage, &c.

ENSIGN, in the military art, a banner under which the soldiers are ranged according to the different companies or parties they belong to. The European ensigns are pieces of taffety with various figures, arms, and devices painted on them in different colours: the Turkish ensigns are horses' tails.

Ensign is also the officer that carries the colours, being the lowest commissioned officer in a company of foot, subordinate to the captain and lieutenant. It is a very honourable and proper post for a young gentleman at his first coming into the army; he is to carry the colours both in assault, day of battle, &c., and should not quit them but with his life; he is always to carry them himself on his left shoulder, only on a march he may have them carried by a soldier. If the ensign is killed, then the captain is to carry the colours in his stead.

ENTABLATURE, in architecture, is that part of an order of a column, which is over the capital, and comprehends the architrave, frieze, and cornice.

ENTAIL, in law, signifies fee-tail, or fee-intailed. See Estate.

ENTIERTIE denotes the whole, in contradistinction to moiety, which denotes the half; and a bond, damages, &c. are said to be entire when they cannot be apportioned.

ENTIRE *tenancy*, signifies a sole possession in one man.

ENTOMOLOGY is that branch of natural history that treats of insects. The study of insects has sometimes been ridiculed as unworthy the attention of men of science; for this, however, there is no just reason; though inferior in point of magnitude, yet they surpass, in variety of structure and singularity of appearance, all the larger branches of the animal world. No one can examine with an attentive eye the subjects of this branch of science without surprise; the great variety of forms, the nice adaptation of their parts to the situation in which each happens to be placed, may excite the amazement of the curious and intelligent mind. The same power and wisdom which are manifested in the order, harmony, and beauty of the heavenly bodies, are equally shewn in the formation of the minutest insect; each has received that mechanism of body, those peculiar instincts, and is made to undergo those different changes, which fit it for its destined situation, and enable it to perform its proper functions. The utility of many insects, either in their living or dead state, as the bee, the crab, the silk-worm, cochineal insect, (see Apis, Coccus, &c.) renders them interesting and important; besides, though diminutive in point of size, they are, in regard to numbers, unquestionably the most distinguished of the works of nature; they are to be found in every situation, in water, in air, and in the bowels of the earth; they live in wood, upon animals, decayed vegetables, and all kinds of flesh, and in every state of its existence down to the most putrid.

The general characters by which insects are distinguished are the following: they are furnished with several, six or more, feet; the muscles are affixed to the internal surface of the skin, which is a substance more or less strong, and sometimes very hard and horny; they do not breathe like larger animals, by lungs or gills situated in the upper part of the body; but by a sort of spiracles, distributed in a series or row on each side the whole length of the abdomen; these are supposed to communicate with a continued chain, as it were, of lungs, or something analogous to them, distributed throughout the whole length of the body; the head is furnished with a pair of what are termed antennæ, or horns, which are extremely different in different tribes, and which, by their structure, &c., form a leading character in the institution of the genera into which insects are divided.

Writers on natural history formerly included snails, worms, and the smaller animals, or animalcules, in general, among insects: these are now more properly placed among the tribe vermes, or worm-like animals. Insects have also been denominated

bloodless animals, which modern discoveries have shewn to be contrary to fact: some of them, as the cimex lectularius, have been frequently used with the microscope, to exhibit in a striking manner the circulation of the blood. In this insect, with a good glass, the vibrations and contractions of the arteries may be distinctly observed.

Most insects are oviparous; of course, the first state in which insects appear is that of an ovum or egg. This relates to the generality of insects, for there are some examples of viviparous insects, as in the genera Aphis, Musca, &c. From the egg is hatched the insect in its second or caterpillar state; this second state has been usually known by the name of eruca, but Linnæus has changed it to that of LARVA, which see; considering it as a sort of masked form or disguise of the insect in its complete state. The larvæ of insects differ very much from each other, according to the several tribes to which they belong; those of the butterfly and moth tribe (phalæna) are generally known by the name of caterpillars; those of the beetle (scarabæus), except such as inhabit the water, are of a thick, clumsy form. The larvæ of the locust, or grasshopper, (gryllus), do not differ very much in appearance from the complete insect, except being without wings. The larvæ of flies, bees, (musca, apis,) &c. are generally known by the name of maggots, and are of thick short form. Those of water-beetles (dytiscus) are of highly singular forms, and differ, perhaps, more from that of the complete insect than any others, except those of the butterfly tribe. Some insects undergo no change of shape, but are hatched from the egg complete in all their parts, and they undergo no farther alteration than that of casting their skin from time to time, till they acquire the complete resemblance of the parent animal. In the larvæ state most insects are peculiarly voracious, as in many of the common caterpillars. In their perfect state some insects, as butterflies, are satisfied with the lightest nutriment, while others devour animal and vegetable substances with a considerable degree of avidity. When the larvæ is about to change into the chrysalis or pupa state, it ceases to feed, and having placed itself in some quiet situation, lies still for several hours, and then, by a sort of effort, it divests itself of its external skin, and immediately appears in the different form of a chrysalis or pupa; in this state likewise, the insects of different genera differ almost as much as the larva. In most of the beetle tribe it is furnished with short legs, capable of some degree of motion, though very rarely exerted. In the butterfly tribe it is destitute of legs; but in the locust tribe it differs very little from the perfect insect, except in not having the wings complete. In most of the fly tribe it is perfectly oval, without any apparent motion or distinction of parts. The pupa of the bee is not so shapeless as that of flies, exhibiting the faint appearance of limbs. Those of the dragon-fly (libellula) differ most widely from the appearance of the complete insect; from the pupa emerges the insect in its ultimate form, from which it never changes, nor receives any farther increase of growth.

Different naturalists have attempted to arrange insects into families and genera, particularly the celebrated Linnæus, whose arrangement may be thus explained. He has formed them into seven families or orders, composing his sixth class of animals, Insecta: he defines an insect, a small animal, breathing through pores on its sides, furnished with moveable antennæ and many feet, covered with either a hard crust or a hairy skin. As introductory to the distinguishing marks of the orders and genera, it will be necessary to enumerate and explain the terms given to the different parts, and the most remarkable of the epithets he has applied to them. The body is divided into head, trunk, abdomen, and extremities.

I. Caput, the head, which is distinguishable in most insects, is furnished with eyes, antennæ, and most frequently with a mouth; the eyes, two, four, six, or eight in number, destitute of eye-lids, are either small and simple; or large, compound, and hemispherical; or polyedral; they are commonly immoveable; they are called stipitati, when placed on a stalk. The antennæ are two articulated moveable processes, placed on the head; they are either, 1. Setacea, setaceous, *i. e.* like a bristle, when they taper gradually from their base, or inserted into the head to their point. 2. Clavatæ, clavated, *i. e.* club-shaped, when they grow gradually thicker from their base to their point. 3. Filiformes, filiform, *i. e.* thread-shaped, when they are of an equal thickness throughout the whole of their length. 4. Moniliformes, moniliform, *i. e.* of the form of a necklace, when they are of an equal thickness throughout, but formed of a series of knobs, resembling a string of

beads. 5. Capitatæ, capitate, when they grow thicker towards the point, and terminate in a knob or head. 6. Fissiles, fissile, *i. e.* cleft, when they are capitate, and have the head or knob divided longitudinally into three or four parts or laminæ. 7. Perfoliatæ, perfoliated, when the head or knob is divided horizontally. 8. Pectinatæ, pectinated, *i. e.* resembling a comb, when they have a longitudinal series of hairs projecting from them, in form of a comb. 9. Barbatæ, barbed, when they have little projections or barbs placed on their sides; they are either longiores, longer than the body; breviores, shorter than the body; or, mediocres, of the same length with the body. The mouth, in most insects, is placed in the under part of the head; sometimes, however, it is situated in the thorax, and in a few instances is entirely wanting; it is furnished with palpæ, or feelers; rostrum, *i. e.* beak or snout; labium, or lip; maxillæ, or jaws, placed transversely, and moving laterally; dentes, or teeth; lingua, or tongue; palatum, or palate: the feelers, which are four or six in number, are attached to the mouth, and have two, four, or three articulations: the stemmata are three prominent shining points on the top of the head.

II. Truncus, the trunk, to which the legs are attached, is situated between the head and the abdomen; it is divided into, 1. The thorax, or chest, which is the superior part. 2. Scutellum, *i. e.* small shield or escutcheon, which is the posterior part. 3. The breast and sternum, which is the inferior part.

III. The Abdomen, that part which contains the stomach, intestines, and other viscera, consists of several annular segments; it is perforated on the sides with spiracula, or breathing-holes; the upper part of it is termed tergum, or back; the inferior part venter, or belly; the posterior part anus.

IV. Artus, the extremities, are the wings, legs, and tail.

(I.) Alæ, the wings, are two or four; they are either, 1. Planæ, *i. e.* plain, such as cannot be folded up by the insect: or 2. Plicatiles, or folding, such as can be folded up by the insect at pleasure. 3. Erectæ, erect, such as have their superior surfaces brought into contact, and stand upright when the insect is at rest. 4. Patentes, spreading; such as are extended horizontally. 5. Incumbentes, incumbent; such as rest on the upper part of the abdomen. 6. Deflexæ, bent down; such as are partly incumbent, but have their exterior edge inclined towards the sides of the abdomen. 7. Reversæ, reversed; such as are incumbent, but inverted. 8. Dentatæ, such as have their edges notched or serrated. 9. Caudatæ, such as have processes extended from their extremitres like a tail. 10. Reticulatæ, netted; when the vessels of the wings put on the appearance of net-work. 11. Pictæ, painted; such as are marked with coloured spots, bands, streaks, lines, or dots. 12. Notatæ, marked with specks. 13. Ornatæ, adorned with little eyes, or circular spots, containing a spot of a different colour in their centre: the central spot is termed pupil; the exterior one is called iris; this may happen either in the primary or secondary wings, on their upper or under surfaces: the superior wing is called primary, and the inferior secondary, to avoid confusion, as they may be at times reversed. The elytra are hard shells, occupying the place of the upper wings. They are for the most part moveable, and are either, 1. Truncata, truncated, when shorter than the abdomen, and terminated by a transverse line. 2. Spinosa, or prickly, when their surfaces are covered with sharp points or prickles. 3. Serrata, serrated, when their edges are notched. 4. Scabra, rough, when their surface resembles a file. 5. Striata, striated, when marked with slender longitudinal furrows, 6. Porcata, ridged, when marked with elevated ridges. 7. Sulcata, furrowed. 8. Punctata, marked with dots. 9. Fastigiata, when formed like the roof of a house. The hemelytra, as it were half-elytra, partaking partly of the nature of crustaceous shells, and membranaceous wings, being formed of an intermediate substance. Halteres, or poisers, are small orbicular bodies placed on stalks, situated under the wings of insects, of the order Diptera.

(II.) Pedes, the legs, are divided into, 1. Femur, or thigh, that part which is joined to the trunk. 2. Tibia, or shank. 3. Tarsus, or foot. 4. Ungues, hooks or nails. 5. Manus, (chela), hands or claws, simple, with a moveable thumb, as in the crab. The hind legs are termed, 1. Cursorii, formed for running. 2. Saltatorii, formed for leaping. 3. Natatorii, formed for swimming.

(III.) Cauda, the tail, which terminates the abdomen, is 1. Solitaria, *i. e.* single. 2. Bicornis, *i. e.* two-horned, or double. 3. Simplex, simple, *i. e.* unarmed. 4. Armata, *i. e.* furnished; 1. with forceps or pincers: 2. with furca, a fork: 3. with one

or more setæ, or bristles: 4. with an aculeus, or sting, either smooth or barbed. A sting is a weapon frequently hollow, with which some insects are furnished, and through which they discharge a poison into the wound they inflict.

The sexes of insects are commonly two, male and female. Neuters are to be met with among those insects which live in swarms, such as ants, bees, &c.

The majority of insects are observed to be annual, finishing the whole term of their lives in the space of a year or less, and many do not live half that time; nay, there are some which do not survive many hours; but this latter period is to be understood only of the animals when in their complete or ultimate form, for the larvæ of such as are of this short duration have in reality lived a very long time under water, of which they are natives; and it is observed, that water insects, in general, are of longer duration than land insects. Some few insects, however, in their complete state, are supposed to live a considerable time, as bees for instance; and it is well known that some of the butterfly tribe, though the major part perish before winter, will yet survive that season in a state of torpidity, and again appear and fly abroad in the succeeding spring; spiders are also thought to live a considerable time, and some species of the genus cancer are said to live several years, especially the common lobster, &c.: it should be observed, however, that these animals, in the opinion of some modern naturalists, constitute a different tribe of beings from insects properly so called. Linnæus has divided insects into seven orders, I. Coleoptera; II. Hemiptera; III. Lepidoptera; IV. Neuroptera; V. Hymeroptera; VI. Diptera; VII. Aptera, which see: and from these the several genera are referred to.

ENTRY, in law, is the taking possession of lands or tenements where the party has a title of entry, or an immediate right to possess them. This may be in person or by attorney, or is an entry in law, which is merely the making continual claim, by law considered equivalent to entry. A right of entry is when a party may have his remedy either by entering into the lands, or by action to recover it. A title of entry is where one has a lawful entry in the land which another has, but has no action to recover it till he has entered.

Entry is a summary remedy against certain species of injury by ouster, or putting out of possession of lands; when the party must make a formal but peaceable entry, declares that he takes possession; or may enter upon any part in the same county in the name of the whole; and if he cannot go upon the land for bodily fear, he may make a claim as near the estate as he can, which must be repeated once within every year and day, and is called continual claim. This remedy is admitted only where the adverse possession originally commenced by wrong, as in the instances technically called abatement, intrusion, or disseisin. On a discontinuance or deforcement the party is put to his action. Even in the former cases, when the original wrongful possessor dies, and the land comes to his heir, the right of entry is tolled, *i. e.* taken away by the descent. If the claimant was under disability, from age, coverture, &c. the entry is not tolled by descent; nor in case of an actual disseisin, unless the disseisor was in peaceable possession for five years. Stat. 32 Henry VIII. c. 33. Entry must be made within 20 years after the claimant's right shall accrue, 21 Jac. I. c. 16; and by 4 and 5 Anne c. 16, no entry shall avail to save this statute, unless an action is commenced and prosecuted with effect upon it within one year after; and, finally, by stat. 5 Ric. II. st. 1. c. 8, entry must be pursued in a peaceable manner; for if one turns or keeps another out of possession forcibly, it is not only the subject of a civil remedy, but of a fine and punishment for a misdemeanor.

Entry, *the writ of*, is a possessory remedy which disproves the title of the tenant or possessor, by shewing the unlawful means by which he entered or continues in possession. It was formerly an usual mode of recovering lands, but is now disused for the more convenient action of ejectment, and is never brought when that remedy can be used. There is much nice technical learning concerning it, which it would be vain to attempt to abridge in a popular work. It derives different denominations from the different cases to which the writ is applied, and those are generally derived from the terms in which it states the wrongful entry to have been made, or sets out the different degrees of descent through which the lands have passed in the possession of the wrongful tenants. After a certain degree of descents these are no longer noticed in the writ. The writ against the immediate wrong doer is called a writ of entry in nature of assize; that upon one descent,

an entry *sur disseisin* in the *per*, and upon an entry where the first disseisor has enfeoffed another, and he a third, it is an entry *sur disseisin in le per et eni.* An entry *in le post* states only that the tenant hath not entry but after *(post)* the disseisin of A. B. which is allowed in cases beyond the foregoing degrees. There are other writs adapted to particular cases, which we shall only mention by name, and refer to the larger dictionaries of the law for their precise meaning: such are

ENTRY *ad communem legem*, for the reversioner of tenants in dower by courtesy for life, &c.

ENTRY *ad terminum qui præteriit*, a writ for the reversioner after the end of a term or estate for life, against a stranger in possession.

ENTRY *in casu consimili.*

ENTRY *in casu proviso.*

ENTRY *causa matrimonii prælocuti.*

Several points of law occur, as to the effect of an entry in the case of joint tenancy and coparcenary; of entry by the heir; of entry to divest an estate; to take advantage of a condition which cannot be investigated here; but in general it may be observed, that a bare entry, without expulsion, makes only a seisin; so that the law thereupon adjudges him in possession who has the right.

ENVELOPE, in fortification, a work of earth, sometimes in form of a simple parapet, and at others, like a small rampart with a parapet: it is raised sometimes on the ditch, and sometimes beyond it.

ENVOY, a person deputed to negotiate some affair with any foreign prince or state. Those sent from the courts of France, Britain, Spain, &c. to any petty prince or state, such as the princes of Germany, the republics of Venice, Genoa, &c. go in quality of envoys, not embassadors; and such a character only do those persons bear, who go from any of the principal courts of Europe to another, when the affair they go upon is not very solemn or important. There are envoys ordinary and extraordinary, as well as embassadors; they are equally the same under the protection of the law of nations, and enjoy all the privileges of embassadors, only differing from them in this, that the same ceremonies are not performed to them.

ENURE, in law, to take place or effect, or be available, as a release made to a tenant for a term of life, shall enure to him in the reversion.

EPACRIS, in botany, a genus of the Pentandria Monogynia class and order. Calyx five-parted; corolla funnel-form, villous; nectariferous scales growing to the germ; capsule five-celled, five-valved; the partitions from the middle of the valves; seeds minute and numerous. There are four species, natives of New Zealand.

EPACT, a number arising from the excess of the common solar year above the lunar, whereby the age of the moon may be found out every year. See CHRONOLOGY. The excess of the solar year above the lunar is 11 days; or the epact of any year expresses the number of days from the last new moon of the old year, which was the beginning of the present lunar year to the first of January. The first year of the cycle of the moon, the epact is 0, because the lunar year begins with the solar. On the second, the lunar year has begun 11 days before the solar year, therefore the epact is 11. On the third, it has begun twice 11 before the solar year, therefore the epact is 22. On the fourth, it begins three times 11 days sooner than the solar year, the epact would therefore be 33; but 30 days being a synodical month, must that year be intercalated; or that year must be reckoned to consist of thirteen synodical months, and there remains three, which is the true epact of the year; and so on to the end of the cycle, adding 11 to the epact of the last year, and always rejecting 30, gives the epact of the present year. Thus to adjust the lunar year to the solar through the whole of 19 years, 12 of them must consist of 12 synodical months each, and 7 of 13, by adding a month of 30 days to every year when the epact would exceed 30, and a month of 29 days to the last year of the cycle, which makes in all 209 days, *i. e.* 19×11; so that the intercalary or embolimæan years in this cycle are 4, 7, 10, 12, 15, 18, 19.

If the new moons returned exactly at the same time after the expiration of nineteen years, as the council of Nice supposed they would do (when they fixed the rule for the observation of Easter, and marked the new moons in the calendar for each year of the lunar cycle) then the golden number multiplied by 11, would always give the epact. But in a Julian century, the new moons anticipate, or happen earlier than that council imagined they would by $\frac{8}{25}$ of a day. In a Gregorian common century, which is one day shorter than a Julian century, they happen $\frac{17}{25}$ of a day later, (1 day $-\frac{8}{25}=\frac{17}{25}$). Now $\frac{17}{25}\times 3=\frac{51}{25}$ for the three common

centuries, but $\frac{18}{25}$ being subtracted, on account of the Gregorian bissextile century, there will remain $\frac{43}{25}$. Therefore in four Gregorian centuries the new moons will happen later by $\frac{43}{25}$ of a day, and the epacts must be decreased accordingly.

At present the Gregorian epact is 11 days short of the Julian epact; but the quotient of the number of the centuries divided by 4, which at this time is 4, multiplied by $\frac{43}{25}$, with the addition of the remainder 1 multiplied by $\frac{17}{25}$, makes in all but $\frac{189}{25}$, or 7 days $+\frac{14}{25}$; therefore $\frac{86}{25}$, *i. e.* 3 days $+\frac{11}{25}$ must be added to complete the 11 days. Whence we have the following

General rule for finding the Gregorian Epact for ever. Divide the centuries of any year of the Christian æra by 4, (rejecting the subsequent numbers;) multiply the remainder by 17, and to this product add the quotient multiplied by 43; divide the product $+$ 86 by 25; multiply the golden number by 11, from which subtract the last quotient; and rejecting the thirties, the remainder will be the epact.

Example for 1808.

$$18 \div = 2$$
$$2 \times 17 = 34$$
$$43 \times 4 + 34 = 206$$
$$206 + 86 \div 25 = 11$$
$$11 \times 4 \text{ (Gold. No.)} = 44$$
$$\frac{44 - 11}{30} = 1 - 3 = \text{Epact.}$$

A shorter rule for finding the epact until the year 1900. Subtract 1 from the golden number, and multiplying the remainder by 11, reject the thirties, and you have the epact.

Example for the year 1808.

Golden Number 4.

$$4 - 1 \times 11 - 30 = 3 = \text{Epact.}$$

EPAULE, in fortification, denotes the shoulder of a bastion, or the place where its face and flank meet, and form the angle called the angle of the shoulder. See BASTION.

EPAULEMENT, in fortification, a work raised to cover sideways, is either of earth, gabions, or fascines, loaded with earth. The epaulements of the places of arms for the cavalry, at the entrance of the trenches, are generally of fascines mixed with earth.

EPAULETTES, in military dress, are a sort of shoulder-knot. They are badges of distinction worn on one or both shoulders, according to the rank of the wearer: and for the same reason they are made either of worsted, or of silver or gold lace. In France all degrees of rank in the army may be instantly known from the epaulette; but this is not the case here. Lately epaulettes have been introduced into the navy, and in that service the following are the gradations of rank as distinguished by them. Masters and commanders have one epaulette on the left shoulder: post captains under three years, one epaulette on the right shoulder, afterwards two epaulettes: rear admirals have one star on the strap of the epaulette, vice-admirals two stars, and admirals three stars.

EPHA, or EPHAH, in Jewish antiquity, a measure for things dry, containing 1.0961 of a bushel. See MEASURE.

EPHEDRA, in botany, a genus of the Dioecia Monodelphia class and order. Natural order of Coniferæ. Essential character: male, calyx of the ament two-cleft; corolla none; stamens seven; anthers four inferior, three superior: female, calyx two-parted, five-fold; corolla none; pistils two; seeds covered with a berried calyx. There are two species; *viz.* E. distachya, great shrubby horse-tail, or sea-grape, and E. monostachya, small shrubby horse tail. These plants vary extremely. Some in the south of Europe are only a hand in height, whilst others are three feet: they are found in most of the southern parts of the Russian dominions, from the Volga to the Lena, and southwards to Persia and India. The berries are sweetish, mucose, and leave a little heat in the throat: they are eaten by the Russian peasants, and the wandering hordes of all Great Tartary.

EPHEMERA, *day-fly*, in natural history, a genus of insects of the order Neuroptera. Mouth without mandibles; feelers four, very short, filiform; antennæ short, filiform; above the eyes are two or three large stemmata; wings erect, the lower ones much shorter; tail terminating in long bristles or hairs. These short-lived animals, of which there are about twenty species, in two divisions, according as they have two or three hairs in the tail, are found every where about waters in the summer, and in their perfect state seldom live more than a day, some of them not an hour, during which time they perform all the functions of life, and answer all the ends of nature. The larva lives under water, and is eagerly sought after by trout and other fish: it is six-footed, active, and furnished with a tail

and six lateral fins or gills; the pupa resembles the larva, except in having rudiments of future wings. The larva is altogether aquatic, the complete insect aerial. In the former state it lives two or three years; but as a perfect animal it survives but a very few hours, perishing in the course of the same evening that gives it birth. The most common species is the E. vulgata, or common May-fly, so plentiful in the early part of summer about the brinks of rivulets and stagnant waters. It is of a greenish colour, with transparent wings, elegantly mottled with brown, and is furnished with three very long black bristles. It flutters in the evening about the surface of the water; but during the day is generally seen in a quiescent posture, with the wings closed, and applied to each other in an upright position.

EPHEMERIDES, in literary history, an appellation given to those books or journals, which shew the motions and places of the planets for every day in the year. It is from the tables contained in these ephemerides, that eclipses, and all the variety of aspects of the planets, are found.

EPHIELIS, in botany, a genus of the Octandria Monogynia class and order. Essential character: calyx five-parted; petals five, with claws; nectary ten scales, two to each petal; capsule oblong, one-celled, two-valved, two-seeded. There is but one species; *viz.* E. guianensis: this is a lofty tree, growing in the forests of Guiana, where it flowers in the month of October.

EPIBATERIUM, in botany, a genus of the Monoecia Hexandria class and order. Essential character: calyx double; outer six-leaved, small; inner three-leaved, large; petals six, three outer, between the calycine leaflets; three inner; drupes three, subglobular, mucronate, with the three permanent styles; inclosing a kidney-form nut. There is only one species; *viz.* E. pendulum.

EPIC, or *heroic poem*, a poem expressed in narration, formed upon a story partly real and partly feigned; representing, in a sublime stile, some signal and fortunate action, distinguished by a variety of great events, to form the morals, and affect the mind with the love of heroic virtue.

EPICHRYSUM, in botany, a genus of the Cryptogamia Fungi class and order. Fungus rounded, concave; seeds globular; tailless, attached to a branched thread creeping within. There is but one species; *viz.* E. argenteum.

EPICUREAN *philosophy*, the doctrine or system of philosophy maintained by Epicurus and his followers.

Epicurus, the Athenian, one of the greatest philosophers of his age, was obliged to Democritus for almost his whole system, notwithstanding he piqued himself upon deriving every thing from his own fund. He wrote a great number of books, which are made to amount to above 300. Though none of them are come down to us, no ancient philosopher's system is better known than his, for which we are mostly indebted to the poet Lucretius, Diogenes Laertius, and Tully. His philosophy consisted of three parts, canonical, physical, and ethereal. The first was about the canons, or rules of judging. The censure which Tully passes upon him for his despising logic, will hold true only with regard to the logic of the Stoics, which he could not approve of, it being too full of nicety and quirk. Epicurus was not acquainted with the analytical method of division and argumentation, nor was he so curious in modes and formation as the Stoics. Soundness and simplicity of sense, assisted with some natural reflections, was all his art. His search after truth proceeded only by the senses, to the evidence of which he gave so great a certainty, that he considered them as an infallible rule of truth, and termed them the first natural light of mankind.

In the second part of his philosophy he laid down atoms, space, and gravity as the first principles of all things. He did not deny the existence of a God, but thought it beneath his majesty to concern himself with human affairs. He held him a blessed, immortal being, having no affairs of his own to take care of, and above meddling with those of others. See Atomic Philosophy.

As to his ethics, he made the supreme good of man to consist in pleasure, and, consequently, supreme evil in pain. Nature itself, says he, teaches us this truth, and prompts us from our birth to procure whatever gives us pleasure, and avoid what gives us pain. To this end he proposes a remedy against the sharpness of pain: this was to divert the mind from it, by turning our whole attention upon the pleasures we have formerly enjoyed. He held that the wise man must be happy, as long as he is wise; that pain, not depriving him of his wisdom, cannot deprive him of his happiness.

EPICYCLE, in the ancient astronomy, a little circle whose centre is in the circumference of a greater circle; or it is a small

orb, or sphere, which being fixed in the deferent of a planet, is carried along with it; and yet, by its own peculiar motion, carries the planet fastened to it round its proper centre.

It was by means of epicycles, that Ptolemy and his followers solved the various phenomena of the planets, but more especially their stations and retrogradations. The great circle they called the excentric or deferent, and along its circumference the centre of the epicycle was conceived to move; carrying with it the planet fixed in its circumference, which in its motion downwards proceeded according to the order of the signs, but, in moving upwards, contrary to that order. The highest point of a planet's epicycle they called apogee, and the lowest perigee.

EPICYCLOID, in geometry, a curve generated by the revolution of the periphery of a circle, A C E (Plate V. Miscel. fig. 4.) along the convex or concave side of the periphery of another circle, D G B.

The length of any part of the curve, that any given point in the revolving circle has described, from the time it touched the circle it revolved upon, shall be to double the versed sine of half the arch, which all that time touched the circle at rest, as the sum of the diameters of the circles, to the semidiameter of the resting circle, if the revolving circle moves upon the convex side of the resting circle; but if upon the concave side, as the difference of the diameters to the semi-diameter of the resting circle.

In the Philosoph. Transactions, No. 218, we have a general proposition for measuring the areas of all cycloids and epicycloids, *viz.* The area of any cycloid or epicycloid is to the area of the generating circle, as the sum of double the velocity of the centre and velocity of the circular motion to the velocity of the circular motion: and in the same proportion are the areas of segments of those curves to those of analogous segments of the generating circle.

EPIDEMIC. A contagious disease is so termed that attacks many people at the same season, and in the same place; thus, putrid fever, plague, dysentery, &c. are often epidemic. Dr. James Sims observes, in the Memoirs of the Medical Society of London, that there are some grand classes of epidemics which prevail every year, and which are produced by the various changes of the seasons. Thus, spring is accompanied by inflammatory diseases; summer by complaints in the stomach and bowels; autumn by catarrhs; and winter by intermittents: these being obviously produced by the state of weather attendant upon them, other epidemics are supposed analogous to them, and obedient to the same rules, which, on examination, not being the case, all further scrutiny is laid aside, perhaps too hastily.

The most natural and healthful seasons in this country are a moderately frosty winter, showery spring, dry summer, and rainy autumn; and whilst such prevail, the wet part of them is infested by vastly the greatest proportion of complaints, but those not of the most mortal kind. A long succession of wet seasons is accompanied by a prodigious number of diseases; but these being mild and tedious, the number of deaths are not in proportion to the coexistent ailments. On the other hand, a dry season, in the beginning, is attended with extremely few complaints, the body and mind both seeming invigorated by it; if, however, this kind of weather last very long, towards the close of it a number of dangerous complaints spring up, which, as they are very short in their duration, the mortality is much greater than one would readily suppose from the few persons that are ill at any one time: and as soon as a wet season succeeds a long dry one, a prodigious sickness and mortality come on universally. So long as this wet weather continues, the sickness scarcely abates, but the mortality diminishes rapidly; so that in the last number of rainy years the number of deaths is at the minimum. The change of a long dry season, whether hot or cold, to a rainy one, appears to bring about the temperature of air favourable to the production of great epidemics. Some, however, seem more speedily to succeed the predisposing state of the air, others less so; or it may be that the state of air favourable to them exists at the very beginning of the change, whilst the state favourable to others progressively succeeds: of this last, however, Dr. Sims is very uncertain.

Two infectious diseases, it appears, are hardly ever prevalent together; therefore, although the same distemperature of air seems favourable to most epidemic disorders, yet some must appear sooner, others later. From observation and books, the Doctor describes the order in which these disorders have a tendency to succeed each other, to be plague, petechial fever, putrid sore throat, with or without scarlatina, dysentery, small-pox, measles, simple scar-

latina, hooping-cough, and catarrh: "I do not mean by this," says he, "that they always succeed each other as above; for often the individual infection is wanting, when another takes its place, until perhaps that infection is imported from a place, which has been so unfortunate as to have a coincidence of the two causes, without which it appears that no epidemic can take place; that is, a favourable disposition of the air, and that particular infection. Whenever it happens that one infectious disorder takes the place that should have been more properly occupied by another, it becomes much more virulent than it is naturally, whilst the former, if it afterwards succeeds, becomes milder in proportion: this, perhaps, is the reason why the same disorders, nay, the same appearance in a disorder, are attended with much more fatality in one year than another."

EPIDENDRUM, in botany, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary turbinate, oblique, reflex; corolla spreading; spur none. There are 124 species. This numerous genus is obscure in its character, differences, and synonyms; for the flowers in dried specimens can hardly be unfolded; the plants are cultivated in gardens with difficulty; and the species have not been sufficiently described by authors, who have had an opportunity of seeing them in America, and the East Indies, their native places of growth.

EPIDERMIS, in anatomy, the same with the cuticle. See CUTIS.

EPIGÆA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Bicornes. Ericæ, Jussieu. Essential character: calyx outer three-leaved; inner five-parted; corolla salver-form; capsule five-celled. There are but two species, *viz.* E. repens, creeping epigæa, or trailing arbutus, and E. cordifolia, heart-leaved epigæa; the former is a native of Virginia and Canada, and the latter of Guadaloupe.

EPIGLOTTIS, one of the cartilages of the larynx or wind-pipe. See ANATOMY.

EPIGRAM, in poetry, a short poem or composition in verse, treating only of one thing, and ending with some lively, ingenious, and natural thought or point.

EPILEPSY, in medicine, the same with what is otherwise called the falling-sickness, from the patient's falling suddenly to the ground.

EPILOBIUM, in botany, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character: calyx four-cleft; petals four; capsule oblong, inferior; seeds downy. There are fourteen species. These plants are hardy perennials, not void of beauty; they are, however, commonly considered only as weeds, and are rarely cultivated in gardens.

EPILOGUE, in dramatic poetry, a speech addressed to the audience after the play is over, by one of the principal actors therein, usually containing some reflections on certain incidents in the play, especially those in the part of the person that speaks it.

EPIMEDIUM, in botany, English *barrenwort*, a genus of the Tetrandria Monogynia class and order. Natural order of Corydales. Berberides, Jussieu. Essential character: nectary four, cupform, leaning on the petals; corolla four-petalled; calyx very caducous; fruit a silique. There is but one species, *viz.* E. alpinum, alpine barrenwort.

EPIPHANY, a christian festival, otherwise called the manifestation of Christ to the Gentiles, observed on the sixth of January, in honour of the appearance of our Saviour to the three magi, or wise men, who came to adore him, and bring him presents. The feast of epiphany was not originally a distinct festival, but made a part of that of the nativity of Christ, which being celebrated twelve days, the first and last of which were high or chief days of solemnity, either of these might properly be called epiphany, as that word signifies the appearance of Christ in the world.

The kings of England and Spain offer gold, frankincense, and myrrh, on epiphany, or twelfth day, in memory of the offerings of the wise men to the infant Jesus.

The festival of epiphany is called by the Greeks the feast of lights, because our Saviour is said to have been baptised on this day; and baptism is by them called illumination.

EPISCOPALIANS, in the modern acceptation of the term, belong more especially to members of the Church of England, and derive this title from episcopus, the Latin word for bishop; or if it be referred to its Greek origin, implying the care and diligence with which bishops are expected to preside over those committed to their guidance and direction. They insist on the divine origin of their bishops, and other church officers, and on the alliance between church and state. Respecting these subjects, however, Warburton and Hoadley, together with others

of the learned amongst them, have different opinions, as they have also on the thirty-nine articles, which were established in the reign of Queen Elizabeth. These are to be found in most Common Prayer-Books; and the Episcopal Church in America has reduced their number to twenty. By some the articles are made to speak the language of Calvinism, and by others they have been interpreted in favour of Arminianism.

The Church of England is governed by the King, who is the supreme head; by two archbishops, and by twenty-four bishops. The benefices of the bishops were converted by William the Conqueror into temporal baronies; so that every prelate has a seat and vote in the House of Peers. Dr. Benjamin Hoadley, however, in a sermon preached from this text, "My kingdom is not of this world," insisted that the clergy had no pretensions to temporal jurisdiction, which gave rise to various publications, termed by way of eminence the Bangorian Controversy, Hoadley being then bishop of Bangor. There is a bishop of Sodor and Man, who has no seat in the House of Peers.

Since the death of the intolerant Archbishop Laud, men of moderate principles have been raised to the see of Canterbury, and this hath tended not a little to the tranquillity of church and state. The established Church of Ireland is the same as the Church of England, and is governed by four archbishops, and eighteen bishops.

EPISODE, in poetry, a separate incident, story, or action, which a poet invents and connects with his principal action, that his work may abound with a greater diversity of events; though, in a more limited sense, all the particular incidents whereof the action or narration is compounded, are called episodes.

EPITAPH, a monumental inscription in honour or memory of a person defunct, or an inscription engraven or cut on a tomb, to mark the time of a person's decease, his name, family; and, usually, some eulogium of his virtues, or good qualities.

EPITHALAMIUM, in poetry, a nuptial song, or composition, in praise of the bride and bridegroom, praying for their prosperity, for a happy offspring, &c.

EPITHET, in poetry and rhetoric, an adjective expressing some quality of a substantive to which it is joined; or such an adjective as is annexed to substantives by way of ornament, and illustration, not to make up an essential part of the description. "Nothing," says Aristotle, "tires the reader more than too great a redundancy of epithets, or epithets placed improperly; and yet nothing is so essential in poetry as a proper use of them."

EPITOME, in literary history, an abridgment or summary of any book, particularly of a history.

EPOCHA, in chronology, a term or fixed point of time, whence the succeeding years are numbered or accounted. See CHRONOLOGY.

EPODE, in lyric poetry, the third or last part of the ode, the antient ode being divided into strophe, antistrophe, and epode.

EPOPOEIA, in poetry, the story, fable, or subject treated of, in an epic poem. The word is commonly used for the epic poem itself. See EPIC.

EPSOM *salt*, another name for sulphate of magnesia.

EQUABLE, an appellation given to such motions as always continue the same in degree of velocity, without being either accelerated or retarded. When two or more bodies are uniformly accelerated or retarded, with the same increase or dimunition of velocity in each, they are said to be equably accelerated or retarded.

EQUAL, a term of relation between two or more things of the same magnitude, quantity, or quality. Mathematicians speak of equal lines, angles, figures, circles, ratios, solids, &c.

EQUALITY, that agreement between two or more things whereby they are denominated equal. The equality of two quantities, in algebra, is denoted by two parallel lines placed between them: thus, $4 + 2 = 6$, that is, 4 added to 2 is equal to 6.

EQUANIMITY, in ethics, denotes that even and calm frame of mind and temper under good or bad fortune, whereby a man appears to be neither puffed up or overjoyed with prosperity, nor dispirited, soured, or rendered uneasy by adversity.

EQUATION, in algebra, the mutual comparing two equal things of different denominations, or the expression denoting this equality; which is done by setting the one in opposition to the other, with the sign of equality ($=$) between them: thus, $3\,s = 36\,d$, or 3 feet $=$ 1 yard. Hence, if we put a for a foot, and b for a yard, we shall have the equation $3\,a = b$, in algebraical characters. See ALGEBRA.

EQUATIONS, *construction of*, in algebra, is the finding the roots or unknown quantities of an equation, by geometrical con-

struction of right lines or curves, or the reducing given equations into geometrical figures. And this is effected by lines or curves, according to the order or rank of the equation. The roots of any equation may be determined, that is, the equation may be constructed, by the intersections of a straight line with another line or curve of the same dimensions as the equation to be constructed: for the roots of the equation are the ordinates of the curve at the points of intersection with the right line; and it is well known that a curve may be cut by a right line in as many points as its dimensions amount to. Thus, then, a simple equation will be constructed by the intersection of one right line with another; a quadratic equation, or an affected equation of the second rank, by the intersections of a right line with a circle, or any of the conic sections, which are all lines of the second order; and which may be cut by the right line in two points, thereby giving the two roots of the quadratic equation. A cubic equation may be constructed by the intersection of the right line with a line of the third order, and so on. But if, instead of the right line, some other line of a higher order be used, then the second line, whose intersections with the former are to determine the roots of the equation, may be taken as many dimensions lower as the former is taken higher. And, in general, an equation of any height will be constructed by the intersection of two lines, whose dimensions multiplied together produce the dimension of the given equation. Thus, the intersections of a circle with the conic sections, or of these with each other, will construct the biquadratic equations, or those of the fourth power, because $2 \times 2 = 4$; and the intersections of the circle, or conic sections, with a line of the third order, will construct the equations of the fifth and sixth power, and so on.—For example:

To construct a simple equation. This is done by resolving the given simple equation into a proportion, or finding a third or fourth proportional, &c. Thus, 1. If the equation be $ax = bc$; then $a : b :: c : x = \frac{bc}{a}$, the fourth proportional to a, b, c. 2. If $ax = b^2$; then $a : b :: b : x = \frac{b^2}{a}$, a third proportional to a and b. 3. If $ax = b^2 - c^2$; then, since $b^2 - c^2 = \overline{b+c} \times \overline{b-c}$, it will be $a : b+c :: b-c : x = \frac{\overline{b+c} \times \overline{b-c}}{a}$, a fourth proportional to a, $b+c$, and $b-c$. 4. If $ax = b^2 + c^2$; then construct the right-angled triangle A B C (Plate V. Miscel. fig. 5.) whose base is b, and perpendicular is c, so shall the square of the hypothenuse be $b^2 + c^2$, which call h^2; then the equation is $ax = h^2$, and $x = \frac{h^2}{a}$ a third proportional to a and h.

To construct a quadratic equation. 1. If it be a simple quadratic, it may be reduced to this form $x^2 = ab$; and hence $a : x :: x : b$, or $x = \sqrt{ab}$, a mean proportional between a and b. Therefore upon a straight line take A B $= a$, and B C $= b$; then upon the diameter A C describe a semicircle, and raise the perpendicular B D to meet it in D; so shall B D be $= x$, the mean proportional sought between A B and B C, or between a and b. 2. If the quadratic be affected, let it first be $x^2 + 2ax = b^2$; then form the right-angled triangle whose base A B is a, and perpendicular B C is b; and with the centre A and radius A C describe the semicircle D C E; so shall D B and B E be the two roots of the given quadratic equation $x^2 + 2ax = b^2$. 3. If the quadratic be $x^2 - 2ax = b^2$, then the construction will be the very same as of the preceding one $x^2 + 2ax = b^2$. 4. But if the form be $2ax - x^2 = b^2$, form a right-angled triangle (fig. .) whose hypothenuse F G is a, and perpendicular G H is b; then with the radius F G and centre F describe a semi-circle I G K: so shall I H and H K be the two roots of the given equation $2ax - x^2 = b^2$, or $x^2 - 2ax = -b^2$.

To construct cubic and biquadratic equations. These are constructed by the intersections of two conic sections; for the equation will rise to four dimensions, by which are determined the ordinates from the four points in which these conic sections may cut one another; and the conic sections may be assumed in such a manner as to make this equation coincide with any proposed biquadratic; so that the ordinates from these four intersections will be equal to the roots of the proposed biquadratic. When one of the intersections of the conic section falls upon the axis, then one of the ordinates vanishes and the equation by which these ordinates are determined, will then be of three dimensions only, or a cubic to which any proposed cubic equation may be accommodated; so that the three remaining ordinates will be the roots of that proposed cubic. The conic sections for this purpose should be such as are most easily described; the

circle may be one, and the parabola is usually assumed for the other. See Simpson's and Maclaurin's algebra.

Equations, *nature of.* Any equation involving the powers of one unknown quantity may be reduced to the form $z^n - p z^{n-1} + q z^{n-2}$, &c. $= 0$: here the whole expression is equal to nothing, and the terms are arranged according to the dimensions of the unknown quantity, the coefficient of the highest dimension is unity, understood, and the coefficients p, q, r, and are affected with the proper signs. An equation, where the index is of the highest power of the unknown quantity is n, is said to be of n dimensions, and in speaking simply of an equation of n dimensions, we understand one reduced to the above form. Any quantity $z^m - p z^{n-1} + q z^{n-2}$, &c. $+ P z - Q$ may be supposed to arise from the multiplication of $\overline{z-a} \times \overline{z-b} \times \overline{z-c}$, &c. to n factors. For by actually multiplying the factors together, we obtain a quantity of n dimensions similar to the proposed quantity, $z^n - p z^{n-1} + q z^{n-2}$, &c.; and if a, b, c, &c. can be so assumed that the coefficients of the corresponding terms in the two quantities become equal, the whole expressions coincide. And these coefficients may be made equal, because these will be n equations, to determine n quantities, a, b, c, &c. If then the quantities a, b, c, &c. be properly assumed, the equation $z^n - p z^{n-1} + q z^{n-2}$, &c. $= 0$, is the same with $\overline{z-a} \times \overline{z-b} \times \overline{z-c}$, &c. $= 0$. The quantities a, b, c, d, &c. are called roots of the equation, or values of z; because, if any one of them be substituted for z, the whole expression becomes nothing, which is the condition proposed by the equation.

Every equation has as many roots as it has dimensions. If $z^n - p z^{m-1} + p z^{n-2}$, &c. $= 0$, or $\overline{z-a} \times \overline{z-b} \times \overline{z-c}$, &c. to n factors $= 0$, there are n quantities, a, b, c, &c. each of which when substituted for z makes the whole $= 0$, because in each case one of the factors becomes $= 0$; but any given quantity, different from these, as e when substituted for z, gives the product $\overline{e-a} \times \overline{e-b} \times \overline{e-c}$, &c. which does not vanish, because none of the factors vanish, that is, e will not answer the condition which the equation requires.

When one of the roots, a, is obtained, the equation $\overline{z-a} \times \overline{z-b} \times \overline{z-c}$, &c. $= 0$, $z^n - p z^{n-1} + q z^{n-2}$, &c. $= 0$ is divisible by $z - a$ without a remainder, and is thus reducible to $\overline{z-b} \times \overline{z-c}$, &c. $= 0$, an equation one dimension lower, whose roots are b and c.

Ex. One root of $x^3 + 1 = 0$, or $x + 1 = 0$, and the equation may be depressed to a quadratic in the following manner:

$$\begin{array}{r}
x+1)\,x^3+1\,(x^2-x+1 \\
x^3+x^2 \qquad\quad \\
\hline
-x^2 \qquad\quad \\
-x^2-x \qquad \\
\hline
+x+1 \\
x+1 \\
\hline
\cdot\ \cdot
\end{array}$$

Hence the other two roots are the roots of the quadratic $x^2 - x + 1 = 0$. If two roots, a and b, be obtained, the equation is divisible by $\overline{x-a} \times \overline{x-b}$, and may be reduced in the same manner two dimensions lower,

Ex. Two roots of the equation $z^6 - 1 = 0$, are $+1$ and -1, or $z - 1 = 0$, and $z + 1 = 0$; therefore it may be depressed to a biquadratic by dividing by $\overline{z-1} \times \overline{z+1} = z^2 - 1$.

$$\begin{array}{r}
z^2-1)\,z^6-1\,(z^4+z^2+1 \\
z^6-z^4 \qquad\qquad \\
\hline
+z^4 \qquad\qquad \\
z^4-z^2 \qquad \\
\hline
+z^2-1 \\
+z^2-1 \\
\hline
\cdot\ \cdot
\end{array}$$

Hence the equation $z^4 + z^2 + 1 = 0$ contains the other four roots of the proposed equation.

Conversely, if the equation be divisible by $x - a$ without a remainder, a is a root; if by $\overline{x-a} \times \overline{x-b}$, a and b are both roots. Let Q be the quotient arising from the division, then the equation is $\overline{x-a} \times \overline{x-b} \times Q = 0$, in which, if a or b be substituted for x the whole vanishes.

Equations, *cubic, solution of, by Cardan's rule.* Let the equation be reduced to the form $x^3 - q x + r = 0$, where q and r may be positive or negative.

Assume $x = a + b$, then the equation becomes $\overline{a+b}|^3 - q \times \overline{a+b} + r = 0$, or $a^3 + b^3 + 3ab \times \overline{a+b} - q \times \overline{a+b} + r = 0$; and since we have two unknown quantities, a and b, and have made only one supposition respecting them, *viz.* that $a + b = x$, we are at liberty to make another; let $3ab$

$-q=0$, then the equation becomes $a^3+b^3+r=0$; also, since $3ab-q=0$, $b=\frac{q}{3a}$, and by substitution, $a^3+\frac{q^3}{27a^3}+r=0$, or $a^6+ra^3+\frac{q^3}{27}=0$, an equation of a quadratic form; and by completing the square, $a^6+ra^3+\frac{r^2}{4}=\frac{r^2}{4}-\frac{q^3}{27}$, and $a^3+\frac{r}{2}=\pm\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}$; therefore $a^3=-\frac{r}{2}\pm\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}$, and $a=\sqrt[3]{-\frac{r}{2}\pm\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}}$. Also, since $a^3+b^3+r=0$, $b^3=-\frac{r}{2}\mp\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}$, and $b=\sqrt[3]{-\frac{r}{2}\mp\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}}$; therefore $x=a+b=\sqrt[3]{-\frac{r}{2}\pm\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}}+\sqrt[3]{-\frac{r}{2}\mp\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}}$.

We may observe that when the sign of $\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}$, in one part of the expression, is positive, it is negative in the other, that is $x=\sqrt[3]{-\frac{r}{2}+\sqrt{\frac{r^2}{4}-\frac{q^2}{27}}}+\sqrt[3]{-\frac{r}{2}-\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}}$.

Since $b=\frac{q}{3a}$, the value of x is also $\sqrt[3]{-\frac{r}{2}-\pm\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}}+\frac{q}{3\sqrt[3]{-\frac{r}{2}\pm\sqrt{\frac{r^2}{4}-\frac{q^3}{27}}}}$.

Ex. Let $x^3+6x-20=0$; here $q=-6$, $r=-20$, $x=\sqrt[3]{10+\sqrt{108}}+\sqrt[3]{10-\sqrt{108}}=2.732-.732=2$.

Cor. 1. Having obtained one value of x, the equation may be depressed to a quadratic, and the other roots found.

Cor. 2. The possible values of a and b being discovered, the other roots are known without the solution of a quadratic.

The values of the cube roots of a^3 are a, $\frac{-1+\sqrt{-3}}{2}a$, and $\frac{-1-\sqrt{-3}}{2}a$; and the values of the cube root of b^3, are b, $\frac{-1+\sqrt{-3}}{2}b$, $\frac{-1-\sqrt{-3}}{2}b$.

Hence, it appears, that there are nine values of $a+b$, three only of which can answer the conditions of the equation, the others having been introduced by involution. These nine values are,

1. $a+b$.
2. $a+\frac{-1+\sqrt{-3}}{2}b$.
3. $a+\frac{-1-\sqrt{-3}}{2}b$.
4. $\frac{-1+\sqrt{-3}}{2}a+b$.
5. $\frac{-1+\sqrt{-3}}{2}a+\frac{-1+\sqrt{-3}}{2}b$.
6. $\frac{-1+\sqrt{-3}}{2}a+\frac{-1-\sqrt{-3}}{2}b$.
7. $\frac{-1-\sqrt{-3}}{2}a+b$.
8. $\frac{-1-\sqrt{-3}}{2}a+\frac{-1+\sqrt{-3}}{2}b$.
9. $\frac{-1-\sqrt{-3}}{2}a+\frac{-1-\sqrt{-3}}{2}b$.

In the operation we assume $3ab=q$, that is, the product of the corresponding values of a and b is supposed to be possible. This consideration excludes the 2d. 3d. 4th. 5th. 7th. and 9th. values of $a+b$, or x; therefore the three roots of the equation are $a+b$; $\frac{-1+\sqrt{-3}}{2}a+\frac{-1-\sqrt{-3}}{2}b$; and $\frac{-1-\sqrt{-3}}{2}a+\frac{-1+\sqrt{-3}}{2}b$.

Cor. 3. This solution only extends to those cases in which the cubic has two impossible roots.

For if the roots be $m+\sqrt{3n}$, $m-\sqrt{3n}$, and $-2m$, then $-q$ (the sum of the products of every two with their signs changed) $=-3m^2-3n$, and $\frac{q}{3}=m^2+n$; also, r (the product of all the roots with their signs changed) $=2m^3-6mn$, and $\frac{r}{2}=m^3-3mn$; and by involution,

$$\frac{r^2}{4}=m^6-6m^4n+9m^2n^2$$

$$\frac{q^3}{27}=m^6+3m^4n+3m^2n^2+n^2-n^3$$

Hence, $\frac{r^2}{4}-\frac{q^3}{27}=-9m^4n+6m^2n^2-n^3=$

$-n \times \overline{9m^4 - 6m^2n + n^2}$, and $\sqrt{\frac{r^2}{4} - \frac{q^3}{27}} = \sqrt{-n} \times \overline{3m^2 - n}$, a quantity manifestly impossible, unless n be negative, that is, unless two roots of the proposed cubic be impossible.

Equations, *biquadratic, solution of, by Des Carte's method.* Any biquadratic may be reduced to the form $x^4 + qx^2 + rx + s = 0$, by taking away the second term. Suppose this to be made up of the two quadratics, $x^2 + ex + f = 0$, and $x^2 - ex + g = 0$, where $+e$ and $-e$ are made the coefficients of the second terms, because the second term of the biquadratic is wanting, that is, the sum of its roots is 0. By multiplying these quadratics together we have $x^4 + \overline{g + f - e^2} \cdot x^2 + \overline{eg - ef} \cdot x + fg = 0$, which equation is made to coincide with the former by equating their coefficients, or making $g + f - e^2 = q$, $eg - ef = r$, and $fg = s$; hence, $g + f = q + e^2$, also $g - f = \frac{r}{e}$, and by taking the sum and difference of these equations, $2g = q + e^2 + \frac{r}{e}$, and $2f = q + e^2 - \frac{r}{e}$; therefore $4fg = q^2 + 2qe^2 + e^4 - \frac{r^2}{e^2} = 4s$, and multiplying by e^2, and arranging the terms according to the dimensions of e, $e^6 + 2qe^4 + \overline{q^2 - 4s} \times e^2 - r^2 = 0$; or, making $y = e^2$, $y^3 + 2qy^2 + \overline{q^2 - 4s} \cdot y - r^2 = 0$.

By the solution of this cubic, a value of y, and therefore of $\sqrt{y}$, or e, is obtained; also f and g, which are respectively equal to $\frac{q + e^2 - \frac{r}{e}}{2}$ and $\frac{q + e^2 + \frac{r}{e}}{2}$, are known; the biquadratic is thus resolved into two quadratics, whose roots may be found.

It may be observed, that which ever value of y is used, the same values of x are obtained.

This solution can only be applied to those cases, in which two roots of the biquadratic are possible and two impossible.

Let the roots be a, b, c, $-\overline{a + b + c}$; then since e, the coefficient of the second term of one of the reducing quadratics, is the sum of two roots, its different values are $a + b$, $a + c$, $b + c$, $-\overline{a + b}$, $-\overline{a + c}$, $-\overline{b + c}$, and the values of e^2, or y, are $\overline{a + b}|^2$, $\overline{a + c}|^2$, $\overline{b + c}|^2$; all of which being possible, the cubic cannot be solved by any direct method. Suppose the roots of the biquadratic to be $a + b\sqrt{-1}$; $a - b\sqrt{-1}$; $-a + c\sqrt{-1}$; $-a - c\sqrt{-1}$; the values of e are $2a$, $\overline{b + c} \cdot \sqrt{-1}$, $\overline{b - c} \cdot \sqrt{-1}$, $-\overline{b - c} \cdot \sqrt{-1}$, $-\overline{b + c} \cdot \sqrt{-1}$ and $-2a$; and the three values of y are $\overline{2a}|^2$, $-\overline{b + c}|^2$, $-\overline{b - c}|^2$, which are all possible, as in the preceding case. But if the roots of the biquadratic be $a + b\sqrt{-1}$, $a - b\sqrt{-1}$, $-a + c$, $-a - c$, the values of y are $\overline{2a}|^2$, $\overline{c + b\sqrt{-1}}|^2$, $\overline{c - b\sqrt{-1}}|^2$, two of which are impossible; therefore the cubic may be solved by Cardan's rule.

Equation, *annual*, of the mean motion of the sun and moon's apogee and nodes. The annual equation of the sun's mean motion depends upon the excentricity of the earth's orbit round him, and is $16\frac{11}{12}$ such parts, of which the mean distance between the sun and the earth is 1000; whence some have called it the equation of the centre, which, when greatest, is 1° 56′ 20″.

The equation of the moon's mean motion is 11′ 40″; of the apogee, 20′; and of its node, 9′ 30″.

These four annual equations are always mutually proportionable to each other; so that when any of them is at the greatest, the three others will also be greatest; and when one diminishes, the rest diminish in the same ratio. Wherefore the annual equation of the centre of the sun being given, the other three corresponding equations will be given, so that one table of the central equations will serve for all.

Equation *of a curve*, is an equation shewing the nature of a curve by expressing the relation between any absciss and its corresponding ordinate, or else the relation of their fluxions, &c. Thus, the equation to the circle is $ax - x^2 = y^2$, where a is its diameter, x any absciss or part of that diameter, and y the ordinate at that point of the diameter; the meaning being that whatever absciss is denoted by x, then the square of its corresponding ordinate will be $ax - x^2$. In like manner the equation

of the ellipse is...... $\frac{p}{a} \cdot \overline{ax - x^2} = y^2$

of the hyperbola is $\frac{p}{a} \cdot \overline{ax + x^2} = y^2$,

of the parabola is............ $px = y^2$.

Where a is an axis, and p the parameter. And in like manner for any other curves.

This method of expressing the nature of curves by algebraical equations, was first

introduced by Des Cartes, who, by thus connecting together the two sciences of algebra and geometry, made them mutually assisting to each other, and so laid the foundation of the greatest improvements that have been made in every branch of them since that time.

EQUATION *of time*, in astronomy and chronology, the reduction of the apparent time or motion of the sun, to equable, mean, or true time. The difference between true and apparent time arises from two causes, the excentricity of the earth's orbit, and the obliquity of the ecliptic. See TIME, *equation of*.

EQUATOR, in geography, a great circle of the terrestrial globe, equidistant from its poles, and dividing it into two equal hemispheres; one north and the other south. It passes through the east and west points of the horizon, and at the meridian is raised as much above the horizon as is the complement of the latitude of the place. From this circle the latitude of places, whether north or south, begin to be reckoned in degrees of the meridian. All people living on this circle, called by geographers and navigators the line, have their days and nights constantly equal. It is in degrees of the equator that the longitude of places are reckoned; and as the natural day is measured by one revolution of the equator, it follows that one hour answers to $\frac{360}{24} = 15$ degrees: hence one degree of the equator will contain four minutes of time; 15 minutes of a degree will make a minute of an hour; and consequently, four seconds answer to one minute of a degree.

EQUATIONAL. See OBSERVATORY.

EQUERRY, in the British customs, an officer of state, under the master of the horse. There are five equerries who ride abroad with his Majesty; for which purpose they give their attendance monthly, one at a time, and are allowed a table.

EQUISETUM, in botany, English *horse-tail*, a genus of the Cryptogamia Filices class and order. Natural order of Filices or Ferns. There are seven species. They are natives of most parts of Europe in woods and shady places.

EQUIANGULAR, in geometry, an epithet given to figures, whose angles are all equal: such are a square, an equilateral triangle, &c.

EQUICRURAL, in geometry, the same with isosceles. See ISOSCELES TRIANGLE.

EQUIDIFFERENT *numbers*, in arithmetic, are of two kinds. 1. Continually equidifferent is when, in a series of three numbers, there is the same difference between the first and second, as there is between the second and third; as 3, 6, 9. And 2. Discretely equidifferent, is when, in a series of four numbers or quantities, there is the same difference between the first and second as there is between the third and fourth: such are 3, 6, 7, 10.

EQUIDISTANT, an appellation given to things placed at equal distance from some fixed point, or place, to which they are referred.

EQUILATERAL, in general, something that hath equal sides, as an equilateral angle.

EQUILATERAL *hyperbola*, one whose transverse diameter is equal to its parameter; and so all the other diameters equal to their parameters: in such an hyperbola, the asymptotes always cut one another at right angles in the centre. Its most simple equation, with regard to the transverse axis, is $y^2 = x - a^2$; and with regard to the conjugate, $y^2 = x^2 + a^2$, when a is the semitransverse, or semiconjugate. The length of the curve cannot be found by means of the quadrature of any space, of which a conic section is any part of the perimeter.

EQUILIBRIUM, in mechanics, is when the two ends of a lever or balance hang so exactly even and level, that neither doth ascend or descend, but keep in a position parallel to the horizon, which is occasioned by their being both charged with an equal weight.

EQUIMULTIPLES, in arithmetic and geometry, are numbers and quantities multiplied by one and the same number or quantity. Hence, equimultiples are always in the same ratio to each other, as the simple quantities before multiplication: thus, if 6 and 8 are multiplied by 4, the equimultiples 24 and 32 will be to each other, as 6 to 8.

EQUINOCTIAL, in astronomy, a great circle of the celestial globe, whose poles are the poles of the world. It is so called, because whenever the sun comes to this circle, the days and nights are equal all over the globe; being the same with that which the sun seems to describe, at the time of the two equinoxes of spring and autumn. All stars directly under this circle, have no declination, and always rise due east, and set full west. The hour circles are drawn at right angles to it, passing through every fifteenth degree; and the parallels to it are called parallels of declination.

EQUINOX, the time when the sun enters either of the equinoctial points, where the ecliptic intersects the equinoctial. It was evidently an important problem in practical astronomy, to determine the exact moment of the sun's occupying these stations; for it was natural to compute the course of the year from that moment. Accordingly this has been the leading problem in the astronomy of all nations. It is susceptible of considerable precision, without any apparatus of instruments. It is only necessary to observe the sun's declination on the noon of two or three days before and after the equinoctial day. On two consecutive days of this number, his declination must have changed from north to south, or from south to north. If his declination on one day was observed to be 21′ north, and on the next 5′ south, it follows that his declination was nothing, or that he was in the equinoctial point about 23 minutes after 7 in the morning of the second day. Knowing the precise moments, and knowing the rate of the sun's motion in the ecliptic, it is easy to ascertain the precise point of the ecliptic in which the equator intersected it. By a series of such observations made at Alexandria, between the years 161 and 127 before Christ, Hipparchus, the father of our astronomy, found that the point of the autumnal equinox was about six degrees to the eastward of the star called spica virginis. Eager to determine every thing by multiplied observations, he ransacked all the Chaldean, Egyptian, and other records, to which his travels could procure him access, for observations of the same kind; but he does not mention his having found any. He found, however, some observations of Aristillus and Timochares, made about 150 years before. From these it appeared evident that the point of the autumnal equinox was then about eight degrees east of the same star. He discusses these observations with great sagacity and rigour: and on their authority, he asserts that the equinoctial points are not fixed in the heavens, but move to the westward about a degree in 75 years, or somewhat less.

This motion is called the precession of the equinoxes, because by it the time and place of the sun's equinoctial station precedes the usual calculations: it is fully confirmed by all subsequent observations. In 1750, the autumnal equinox was observed to be 20° 21′ westward of spica virginis. Supposing the motion to have been uniform during this period of ages, it follows that the annual precession is about $50''\frac{1}{3}$; that is, if the celestial equator cuts the ecliptic in a particular point on any day of this year, it will on the same day of the following year, cut it in a point $50''\frac{1}{3}$ to the west of it, and the sun will come to the equinox 20′ 23″ before he has completed his round of the heavens. Thus the equinoctial, or tropical year, or true year of seasons, is so much shorter than the revolution of the sun or the sidereal year. It is this discovery that has chiefly immortalized the name of Hipparchus, though it must be acknowledged that all his astronomical researches have been conducted with the same sagacity and intelligence. It was natural, therefore, for him to value himself highly for the discovery. It must be acknowledged to be one of the most singular that has been made, that the revolution of the whole heavens should not be stable, but its axis continually changing. For it must be observed, that since the equator changes its position, and the equator is only an imaginary circle, equidistant from the two poles, or extremities of the axis, these poles, and this axis must equally change their positions. The equinoctial points make a complete revolution in about 25,745 years, the equator being all the while inclined to the ecliptic in nearly the same angle. Therefore the poles of this diurnal revolution must describe a circle round the poles of the ecliptic, at the distance of about $23\frac{1}{2}$ degrees in 25,745 years; and in the time of Timochares, the north pole of the heavens must have been 30 degrees eastward of where it now is.

EQUITY, *quasi æqualitas*, is generally understood in law, a liberal correction, or qualification of the law, where it is too strict, too confined, or severe, and is sometimes applied, where, by the words of a statute, a case does not fall within it, yet being within the mischief, the judges, by an equitable construction, have extended its application to that case. Equity is understood as a correction of the law: the difference between courts of equity and law is known only in this country, and arises principally, if not entirely, from the different modes of trial which must ever render them essentially distinct. For it is obvious, that where men form contracts in the ordinary course of law, the legal consequence, and the enforcement of them, must be, according to general rules, applicable to general cases; and the nature of our

mode of trial by jury, is so strict in the evidence which it requires, that a strict legal decision, alone can justly be founded upon it. There are, however, many cases in which there are particular circumstances between the different parties peculiar to their case, which give rise to exceptions and equitable decisions wholly different from the general rule. These cases of exception are such, that unless the judge can inquire into all the circumstances affecting the conscience of the several parties, a perfectly equitable decision cannot be given. For this purpose the court of equity is empowered to examine all the litigant parties upon their oaths, and to make every one answer to the full, as to all the circumstances affecting the case, which is not done in a court of law, where no person can be a witness in his own cause.

In equity, however, the plaintiff by filing his bill, waves the objection, and submits to take the answer of each defendant, though he cannot be admitted to give evidence himself. This is the process by what is called English bill in equity, and the form of proceeding, though somewhat tardy, gives the parties the fullest opportunity of obtaining a final decision according to good conscience. It is this difference in the proceeding, which has rendered the best judges in courts of law, averse to introducing equitable distinctions and principles applicable to courts of equity in courts of law, because they have not the same means of informing their consciences upon all the circumstances necessary, to induce them to alter the strict law according to the peculiar facts, or conscientious circumstances of the case. Formerly, it is supposed, the King, upon petition, referred the case upon a harsh decision at law to a committee, together with the Chancellor; but in the time of Edward III. when uses, or trusts of lands, which were discountenanced at common law, were considered as binding in conscience by the clergy, John Waltham, Chancellor to Richard II. introduced the writ of *subpœna*, returnable in the Court of Chancery only, to make the tenant, or feoffee to uses, answerable for the confidence reposed in him, and this writ is the commencement of a suit in equity, which has been chiefly modelled by Lord Ellesmere, the great Lord Bacon, and Sir Heneage Finch, in the time of Charles I. Lord Hardwicke followed, at some distance, after these great men, and by his decisions, together with those of his successors, has established a practical system of equity, which is as definite and well understood as the law itself; and taking into consideration the leading circumstances above mentioned, is nothing more than the law administered according to the justice of the case. There are some cases which belong more peculiarly to a court of chancery, as the care of infants, and appointing guardians to them, so of lunatics and charities, in which the Chancellor acts for the King as keeper of his conscience. In other cases, as in cases of trust, matters of fraud, account, suits for a discovery, matters of accident, and the like, courts of equity act, in aid of the courts of law, and give relief, where, from the nature of the case, a court of law cannot relieve. Thus, where an agreement is to be performed, courts of law can only give damages for the breach, but a court of equity, taking all the circumstances into consideration, directs and enjoins a specific performance of it according to good conscience. So where it apprehends an injury likely to be done, it will interfere to prevent it.

We have thought this explanation of the general principles, which distinguish courts of law and equity, better suited to a work like the present, than an attempt to abridge any more particular account of the practice and principles of courts of equity, which will be found to proceed upon the ordinary rules of good conscience, as far as they can be reduced to practice. An appeal lies from the Chancellor to the House of Lords. The Court of Exchequer has a court of equity, and so have most courts of peculiar jurisdiction.

Equity *of redemption.* Upon a mortgage, although the estate upon non-payment of the money becomes vested in the mortgagee, yet equity considers it only a pledge for the money, and gives the party a right to redeem, which is called his equity of redemption. If the mortgagee is desirous to bar the equity of redemption, he may oblige the mortgager either to pay the money, or be foreclosed of his equity, which is done by proceedings in the Court of Chancery by bill of foreclosure.

EQUUS, the *horse*, in natural history, a genus of mammalia of the order Belluæ. Generic character: upper fore-teeth parallel, and six in number; in the lower jaw six, rather more projecting; tusks on each side, in both jaws, remote from the rest; feet with undivided hoofs. There are six species, and very many varieties.

E. caballus, or the common horse. The elegance, grace, and usefulness of the horse entitle him to particular attention, and certainly confer upon him a pre-eminence above all other quadrupeds. There are few parts of the world in which horses are not to be found; and in various parts of Africa they maintain their original independence, and range at pleasure in herds of several hundreds, having always one or more as an advanced guard, to alarm against approaching danger. These alarms are expressed by a sudden snorting, at which the main body gallop off with the most surprizing swiftness. In the south of Siberia also, and at the north-west of China, wild horses are to be found in considerable abundance; and it is stated, that different herds will carry on hostilities, and one party frequently surround an enemy inferior in number, and conduct them to the hostile territory, manœuvering perpetually to baffle all their attempts to escape. On each bank of the river Don, towards the Palus Mœotis, horses are found wild, but are supposed to be the descendants of domesticated horses, belonging to the Russian army occupied in the siege of Asoph, at the close of the seventeenth century. In America, likewise, horses are found wild in vast abundance, sweeping the extensive plains of Buenos Ayres, and the Brazils particularly, in immense herds. They are taken by the inhabitants by being entangled in a noosed cord, and are often destroyed merely for their hides, as an article of commerce. These American horses are the descendants of those which were introduced by the Spaniards on their discovery of America, as none having previously existed on that continent. They are, in general, small and clumsily formed, and their height rarely above fourteen hands. In the deserts of Arabia it has been stated by several writers, wild horses are extremely abundant, but Shaw and Sonnini, with greater probability, confine their appearance in that country to the borders of the desert, the latter not supplying materials for their subsistence. Mr. Bruce mentions the horses of Nubia as unequalled in beauty, and far superior to those of Arabia. Of the former little notice has been taken but from that observant traveller; of the latter the fame has long been distinguished, and the Arabian horse, celebrated for his beauty and swiftness, has been long exported to the most remote countries of Europe, to correct and improve the native breeds. In Arabia almost every man possesses his horse, which lives in the same apartment or tent with his family, and is considered as constituting by no means the least important part of it. Harsh and violent applications, such as the whip or spur, are rarely inflicted on it. It is fed with the most regular attention, and cleaned with incessant assiduity. The Arab occasionally appears to carry on a conversational intercourse with his horse, and his external attachment to this animal excites in return a corresponding affection. The horse being purified under his management from every vicious propensity, and guarded against casual injury with the utmost solicitude, suffering the infant children to climb its legs without the slightest attempt to kick or shake them off. The Arabs never cross the breeds of horses, and preserve the genealogies of these animals for a considerable number of generations. The horses of Barbary are in high reputation, also, for speed and elegance, as are likewise those of Spain. In various parts of the East, as in India and in some parts of China, there exists a race of these animals, scarcely exceeding the height of a large mastiff, and with their diminutive size are generally connected not a little intractability and mischievousness. In no country of the globe has the breeding of the horse been attended to on more enlarged and philosophic principles than in Great Britain, and with such success have the efforts of the English on this subject been attended, that their horses are in the highest estimation throughout Europe, and in periods of national tranquillity constitute an important article of exportation. Their race-horse is not excelled in fleetness or beauty by the coursers of Barbary or Arabia, and in supporting a continuance of intense effort is far superior to them both. Details of the exploits of English racers form a subject of extreme interest to a particular description of readers, and cannot be considered by any admirers of nature as beneath attention. Out of innumerable instances which have been authenticated, we shall just mention, that Bay Malton, belonging to the Marquis of Rockingham, ran four miles on the York course in seven minutes and forty-four seconds. The celebrated Childers is supposed to have been the fleetest horse ever known in the world. He was opposed by all the most distinguished horses of his day, and what is, perhaps, unprecedented in such a variety of contests, in every instance

bore off the prize. He is stated to have run a mile in very little more than a minute, and his general progress on a four mile course was at the rate of eighty-two feet and a half in a second. Eclipse was almost equally swift with Childers, and was considerably stronger. His form was by no means considered as handsome, as indeed his dimensions deviated very considerably from those which were supposed to constitute the standard of perfect beauty in the horse; but on the most minute examination, his structure was found to be contrived with the most exquisite mechanism for speed. This horse died at the age of twenty-six years, which though unquestionably great, has been often considerably exceeded. Matchem, another celebrated racer, died at the age of thirty-two. For the race-horse see Mammalia, Plate XI. fig. 1.

The hunter is another distinct class of horses in England, where it is brought, by minute attention to breeding, to a high degree of excellence. With a considerable portion of the speed of the race-horse, it combines inexpressibly more strength; and the exertions which it often endures and survives in violent chases of several hours continuance, are a decided proof of its vigour and value.

The draught-horse constitutes another class of these most interesting animals, and is no where advanced to such size and power as in Great Britain. Yorkshire and Lincolnshire are the most celebrated counties for this breed, whence several have been brought to London which have each, for a short distance drawn, without difficulty, the weight of three tons, half of which is considered as the regular draught. A horse of this class was exhibited as a curiosity in London in the year 1805, no less than twenty hands in height. For the cart-horse see Mammalia, Plate XI. fig. 2.

The colour of the horse is generally considered as a matter of trifling consequence. A bright or shining bay appears in this country to obtain the preference. In China, what are called pie-bald horses, are in particular estimation. On occasions of particular state in England, eight horses of a cream colour draw the royal carriage. The ancients appear to have connected their ideas of pomp and dignity on similar occasions with the perfect white, in allusion to which the classics furnish an infinity of circumstances. Absolute whiteness in the horse is, in this country, in almost every instance, the effect of age, which expunges the dark spot of the original grey. The improvement of the horse has, within a few years, been an object of the attention of government, as well as of enlightened individuals; and establishments have been formed on a liberal scale for the promotion of veterinary science. In France the government has recently devoted considerable attention to this highly important subject; and, during the last year only (1807) a very considerable number of veterinary schools or colleges were instituted in the capital, and the principal cities of the departments.

E. asinus, the ass. A warm climate is favourable to this species (as also indeed to the horse), which is found in various parts of Africa in a state of nature, in which it is gregarious, and displays very considerable beauty, and even sprightliness. In the mountainous territories of Tartary, and in the south of India and Persia, asses occur in great abundance, and are said to be here either absolutely white, or of a pale grey. Their hair also is reported to be bright and silky. In Persia asses are extremely in use, and supply for different purposes two very different races, one heavy and slow, and the other slight, sprightly, and agile, which last is exclusively kept for the saddle. The practice is prevalent in that country of slitting the nostrils of these animals, by which it is imagined they breathe with greater freedom, and can consequently sustain greater exertion. The ass is stated to have been unknown in England before the reign of Elizabeth. It is now, however, completely naturalized, and its services to the poor, and consequently to the rich, are of distinguished, and almost indispensible importance. With respect to food, a little is sufficient for its wants, and the most coarse and neglected herbage supplies it with an acceptable repast. The plaintain is its most favourite herbage. In the choice of water it is, however, extremely fastidious, drinking only of that which is perfectly pure and clear. It is one of the most patient and persevering of animals, but in connection with these qualities, it possesses also great sluggishness, and often obstinacy. Owing to the extreme thickness of its skin, it possesses little sensibility to the application of the whip or the stings of insects, and the want of moisture, united to the above circumstance, precludes it more effectually than, perhaps, any other quadruped, from the annoyance of vermin. The

Fig.1. **Equus** *caballus: Race Horse _ Fig.2. Cart Horse _ Fig.3.* **E.** *asinus : Mule. Fig.4* **E.** *zebra : Zebra.*

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ass is remarkable for particular caution against wetting its feet, to avoid which it will make various turns and crossings on the road. It seldom lies down to sleep, unless it is particularly fatigued, and sleeps considerably less than the horse. It is capable of being taught a variety of exercises, and though regarded as a just emblem of stupidity, is far more susceptible and docile than is generally imagined, though unquestionably far inferior to the horse in these respects. Its bray is harsh and disgusting, particularly that of the male. The female has been considered by many naturalists as incapable of braying, contrary, in this country, most certainly, to the most frequent and obvious facts. Her voice is somewhat shriller and weaker than the male. In several countries of Africa, and in some islands of the Archipelago, asses are hunted for food, and their flesh is regarded as highly nutritious and agreeable. In England their milk is in high esteem in cases of debility and decline, and where the stomach of the patient is incapable of digesting the more strong and oily produce of the cow. In America, the ass was introduced by the Spaniards, and on the southern continent of that quarter of the world these animals are found at present in vast herds, having multiplied to an extreme degree, and being frequently hunted by the natives, who contrive to surround a particular herd, and enclosing them gradually within a very small compass, entangle as many as they chuse to take by throwing over each a noosed cord with unfailing dexterity. The animal is then fettered with extreme ease, and left in that state upon the ground till the conclusion of the chase, which sometimes is continued for two or three days. They are as swift as horses, and, indeed, in all ages, the wild ass has been considered as distinguished by rapidity. They attack and defend both with the hoof and teeth in the same manner as horses. The slowness and sluggishness of the ass have frequently excited ludicrous feelings, and it is related of Crassus, that the only occasion on which he was ever known to laugh, was at an ass eating thistles. The habits of the ass, however, do not appear certainly a more fertile subject of ridicule than those of that philosopher.

The mule is a hybrid animal, between the horse and the ass, and from its barrenness, affords unquestionable evidence of the distinctness of these two species. In mountainous districts the mule is extremely serviceable as a beast of burden, as it moves over steep and rugged roads with astonishing firmness, steadiness, and facility. In England these animals are but little used, and where they are employed, it is almost uniformly in the above situations. The breed in this country has been considerably improved within a short period, by the importation of asses from Spain, where mules are in the highest estimation, and employed by the first orders of the opulent and noble, both for the saddle and the carriage. They are not unfrequently sold in that kingdom at the price of sixty or seventy guineas. To those who reside in a country abounding with precipitous passes and rugged roads, mules are invaluable, on account of their steadiness and accuracy of step. In the Alps they are uniformly employed by travellers to descend roads, the narrowness, obliquity, and danger of which fill the rider with something approaching to consternation.

Their manner, on particular occasions of perilous and steep descent, is worthy of being mentioned. Among the Alps the path often occupies only the space of a few feet in width, having on one side an eminence of perpendicular ascent, and on the other a vast abyss, and, as it generally follows the direction of the mountains, presents frequently declivities of several hundred yards. On arriving at one of these the mule, for a moment halts, and no effort of the rider can for the time urge it forward. It appears alarmed at the contemplation of the danger. In a few moments, however, it places its fore feet as it might be supposed to do in the act of stopping itself, and almost immediately closes its hinder feet, somewhat advancing them, so as to give the idea of its intention to lie down. In this attitude it glides down the descent with astonishing rapidity, yet amidst all its speed, retains that self government which enables it to follow, with the most perfect precision, all the windings of the road, and to avoid every impediment to its progress and security. During these singular and critical movements, the rider must be cautious to avoid the slightest check, and must devote his attention to the preservation of his seat without deranging the equilibrium of the mule, the least disordering of which would be inevitably fatal. By long experience on these perilous roads, some mules have acquired the most admirable and astonishing dexterity, and having been in particular requisition from their extraordinary

skill and fame, have become a source of corresponding profit to their owners. See Mammalia, Plate XI. fig. 3.

E. zebra, or the zebra, is somewhat larger than the ass, and far more elegant in its form, particularly with respect to the head and ears. It is either of a milk white or cream colour, adorned on every part with brownish-black stripes, running transversely on the limbs and body, and longitudinally on the face, and arranged with exquisite order, and attended with extreme brilliancy and beauty. These animals inhabit in Africa from Ethiopia to the Cape of Good Hope, between which they exist in vast herds, possessing much of the habits of the wild horse and ass. Like them they are extremely vigilant, and extremely fleet, and so fearful of the sight of man, that, on his first appearance, they fly off with all possible rapidity. They are of an untractable temper, and the attempts which have been made to domesticate them, have in no instance been attended with complete success. Even when taken young, and brought up with particular assiduity, they have yet exhibited a disposition so wild and vicious, as to give little hope that this beautiful race of creatures will ever eventually be of great service to mankind. Our slight acquaintance, however, with them would render a positive decision to this purpose exceedingly premature. Should the zebra ever be made safely and easily convertible to the same purposes as the horse, an elegant variety would be added to the luxuries of the great and opulent. See Mammalia, Plate XI. fig. 4.

E. quagga is marked with fewer stripes than the zebra, and those few of a browner colour and larger size. The hinder parts of this animal are not striped, but spotted. It is found in Africa, is gregarious, extremely fleet, and more tractable than the last species, so much so indeed, that by the Dutch settlers at the Cape, it has been occasionally employed for the purposes both of draught and saddle. The same parts of Africa abound both in the quagga and the zebra, but the two species are never seen together.

E. bisulcus, or the huemel, is a native of South America, particularly of the rugged districts of the Andes. It resembles the ass in general form, and the horse in voice, and in the smallness and neatness of its ears; it is distinguished from both, and from every other known species of the equine genus, by having a divided hoof, and constitutes a link between the cloven-hoofed and whole-hoofed quadrupeds.

ERECTOR. See ANATOMY.

ERICA, in botany, *heath*, a genus of the Octandria Monogynia class and order. Natural order of Bicornes. Ericæ, Jussieu. Essential character: calyx four-leaved; corolla four-cleft; filaments inserted into the receptacle; anthers cloven; capsule four-celled. There are eighty-four species. These are small shrubs. Their leaves are linear, lanceolate or ovate, imbricate or remote, entire, ciliate or serrate, in some opposite, in most whorled, in others again scattered; bractes usually three; the flowers are either axillary or terminating, and variously disposed; corolla mostly of a purple colour; anthers usually oblong, though sometimes linear; germ in most species smooth.

ERIDANUS, in astronomy, a constellation of the southern hemisphere; containing, according to different authors, 19, 30, or even 68 stars.

ERIGERON, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: receptacle naked; down hairy; corolla of the ray linear, and very narrow. There are thirty species.

ERINACEUS, the *hedge-hog*, in natural history, a genus of Mammalia, of the order Feræ. Generic character: two fore teeth, both above and below, those of the upper jaw distant, those of the lower approximated; five tusks on each side of the upper jaw, three on each side of the lower; four grinders on each side, both above and below; body covered on the upper part with spines. There are six species.

E europæus, the common hedge-hog, is found in all the temperate climates of Europe and Asia. Its whole length is about eleven inches, its colour generally a grey brown. It lives in hedges and thickets, and subsists on young toads, worms, beetles, crabs, fruits, and birds. It conceals itself in its hole during the day, and by night wanders in search of food. It builds its nest of moss, and produces four or five young ones at a birth. These animals possess the curious, though not completely singular property of rolling themselves into a compact form, like a ball, their spines only appearing, and presenting to the enemy an armed front, which he generally trembles to assail. The greater the danger it is exposed to, the more closely it is compacted, and it is difficult to compel it from

this state to its usual form without the application of cold water, on being immersed in which, it appears in its usual shape. It lies in this ball-like form during the winter in its mossy nest, insensible to the extremity of the cold, and, on the approach of spring, resumes its nocturnal researches. It is perfectly harmless, and in some countries is said to be domesticated, and in this state is employed by the Calmucks in their habitations to clear them from various annoying insects. It possesses a considerable odour of musk. It is occasionally hunted by dogs, which, however, before they are disciplined to the pursuit, are not fond of encountering these animals, being deterred by their horrid aspect, or wounding bristles. They soon, however, find their superiority, and after a little irritation from the spines of the animal, are exasperated to the full application of their teeth, which the hedge-hog is totally unable to resist. Finding his globular form now cease to be his effectual security, he unrolls himself, and falls an immediate victim to the dogs, who are generally urged on to the sport by persons of far greater curiosity than sensibility. See Mammalia, Plate XII. fig. 1.

E. malaccensis, or the Malacca hedgehog, is about the size of the common porcupine; its ears are long and pendulous, and its spines, or rather quills, are stated to vary on different parts of the animal from the length of an inch to a foot and a half. It is remarkable for a concretion in the gall-bladder about the size of a walnut, which is intensely bitter, and which, in the days of medical ignorance and superstition, was imagined to possess the highest virtue in cases of fever and other malignant diseases, and, when found entire, has been sold occasionally for more than two hundred pounds. These bezoars, however, are by no means peculiar to this animal. See Mammalia, Plate XII. fig. 2.

ERINUS, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx five-leaved; corolla border five-cleft, equal, with the lobes, emarginate; upper lip very short, reflex; capsule two-celled. There are thirteen species. The flowers in this genus are either axillary, or with one bracte to each, in a terminating spike; leaves alternate. They are chiefly natives of Africa.

ERIOCAULON, a genus of the Triandria Tryginia class and order. Natural order of Ensatæ. Junci, Jussieu. Essential character: calyx common, an imbricate head; petals three, equal; stamina upon the germ. There are six species.

ERIOCEPHALUS, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: receptacle subvillose; down none; calyx ten-leaved, equal; in the ray five floscules. There are two species, *viz.* E. africanus, cluster-leaved eriocephalus, and E. racemosus, silvery-leaved eriocephalus. Both natives of the Cape of Good Hope.

The leaves of the first mentioned are woolly; they come out in clusters, some taper and entire, others divided into three pairs, which spread open like a hand; they have a strong smell when bruised, approaching to that of lavender cotton, though not so rank. The flowers are produced in small clusters at the ends of the branches, standing erect. The female florets which compose the ray form a hollow, in the middle of which the hermaphrodite florets forming the disk are situated.

ERIOPHORUM, in botany, *cotton grass*, a genus of the Triandria Monogynia class and order. Natural order of Calamaria. Cyperoideæ, Jussieu. Essential character: glumes chaffy, imbricate every way; corolla none; seed one, surrounded with a very long wool. There are six species. These are bog plants, and are nearly allied to the grasses; they are rarely cultivated in gardens.

ERIOSPERMUM, in botany, a genus of the Hexandria Monogynia class and order. Corolla six petalled, campanulate, permanent; filaments dilated at the base; capsule three-celled; seeds invested with wool. There are three species.

ERIOSTEMUM, in botany, a genus of the Decandria Monogynia class and order. Calyx five-parted; petals five, sessile; stamina flat, ciliate; antheræ pedicelled terminal; style from the base of the germ; capsules five, united, seated on a nectary covered with protuberances; seeds coated. One species, *viz.* E. australasia.

ERITHALIS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: corolla five-parted, with the divisions bent back; calyx pitcher-shaped; berry ten-celled, inferior. There are two species, *viz.* the fruticosa and polygama.

ERMIN. See MUSTELA.

Ermin, in heraldry, is always argent and sable, that is, a white field, or fur, with black spots. These spots are not of any determinate number, but may be more or less, at the pleasure of the painter, as the skins are thought not to be naturally so spotted; but serving for lining the garments of great persons, the furriers were wont, in order to add to their beauty, to sow bits of the black tails of the creatures that produced them, upon the white of their skin, to render them the more conspicuous, which alteration was introduced into armoury.

ERMINE', or cross erminé, is one composed of four ermin spots. It is to be observed, that the colours in these arms are not to be expressed, because neither this cross nor these arms can be of any other colour but white and black.

ERNODEA, in botany, a genus of the Tetrandria Monogynia class and order. Essential character: calyx four-parted; corolla one-petalled, salver-shaped; berry two-celled; seeds solitary. There is but one species, *viz.* E. littoralis, a native of Jamaica.

ERODIUM, in botany, *cranes-bill*, a genus of the Monadelphia Pentandria class and order. Natural order of Gruinales. Gerania, Jussieu. Calyx five-leaved; corolla five-petalled; nectary five-scales, alternate with the filaments and glands at the base of the stamens; fruit five-grained, with a spiral beak, bearded on the inside. There are twenty-eight species.

ERODIUS, in natural history, a genus of insects of the order Coleoptera. Antennæ moniliform; feelers four, filiform; body roundish, gibbous, immarginate; thorax transverse; shells closely united, longer than the abdomen; jaw horny, bifid; lip horny, emarginate. There are four species.

EROTEUM, in botany, a genus of the Polyandria Monogynia class and order. Essential character: calyx five-leaved; corolla five-petalled; style trifid; berry juiceless, three-celled, many-seeded. There are two species, *viz.* E. thœoides, and E. undulatum, both natives of Jamaica.

ERROR, in law, signifies an error in pleading, or in the process on the judgment; and the writ which is brought for remedy of it is called a writ of error. This is a commission to judges of a superior court, by which they are authorized to examine the record upon which a judgment was given in an inferior court, and on such examination, to affirm or reverse the same according to law. For particulars as to the practice of writs of error, see Tomlins's "Law Dictionary."

ERUCTATIONS, in medicine, are the effect of flatulent foods, and the crudities thence arising.

ERUDITION, denotes an extensive acquaintance with books, especially such as treat of the belles lettres.

ERUPTION. See Medicine.

ERVUM, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx five-parted, the length of the corolla. There are six species; of which E. lens, flat-seeded tare, or common lentil, is an annual plant, and the least of the pulse kind which is cultivated; it rises with weak stalks a foot and a half high, having pinnate leaves at each joint, composed of several pairs of narrow leaflets, terminated by a tendril, which supports it by fastening about some other plant; the flowers come out on short peduncles from the sides of the branches; they are small, of a pale purple colour, and three or four together; legumes short and flat, containing two or three flat, round seeds, a little convex in the middle; the flowers appear in May; the seeds ripen in July.

ERYNGIUM, in botany, English *eryngo*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: flowers in a head; receptacle chaffy. There are eleven species; these bear some resemblance to the thistles; the leaves are frequently spinous, as are also the involucres; the umbellets in some are inclosed in an involucre, which is often irregular and branched; in others they are dispersed.

ERYSIMUM, in botany, *hedge-mustard*, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ. Cruciferæ, Jussieu. Essential character: silique columnar with four equal sides; calyx closed. There are eight species.

ERYSIPELAS. See Medicine.

ERYTHRINA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx two-lobed; corolla standard very long, lanceolate. There are seven species; these are small, prickly trees, or shrubs; leaves as in dolichos, ternate, stipulaceous; the petiolules jointed and awned, or glandular, seldom simple; flowers in fascicles from the

axils, or in spikes at the ends of the stem and branches, generally scarlet.

ERYTHRONIUM, in botany, *dog-tooth violet*, a genus of the Hexandria Monogynia class and order. Natural order of Sarmentaceæ. Lilia, Jussieu. Essential character: corolla six-petalled, bell-shaped; nectary tubercles two, fastened to the base of the alternate petals. There is but one species with several varieties, *viz*. E. dens canis, dog-tooth violet; the roots of this plant are white, oblong, and fleshy, shaped like a tooth, whence its name.

ERYTHROXYLON, in botany, a genus of the Decandria Trigynia class and order. Natural order of Malpighiæ, Jussieu. Essential character: calyx turbinate; corolla having a small emarginate nectareous scale at the base of the petals; stamina connected at the base; drupe one-celled. There are five species.

ESCALLONIA, in botany, so named in honour of M. Escallon, a genus of the Pentandria Monogynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character: calyx surrounding the fruit; stigma capitate; berry two-celled, containing many seeds. There are two species, *viz*. E. myrtilloides, and E. serrata.

ESCAPE, in law, is where one who is arrested gains his liberty before he is delivered by course of law. Escapes are either in civil or criminal cases; and in both respects may be distinguished into voluntary and negligent; voluntary, where it is with the consent of the keeper; negligent, where it is for want of due care in him. In civil cases, after the prisoner has been suffered voluntarily to escape, the sheriff can never retake him, but must answer for the debt; but the plaintiff may retake him at any time. In the case of a negligent escape, the sheriff, upon fresh pursuit, may retake the prisoner; and the sheriff shall be excused, if he has him again before any action brought against himself for the escape. When a defendant is once in custody in execution, upon a *capias ad satisfaciendum*, he is to be kept in close and safe custody; and if he be afterwards seen at large, it is an escape, and the plaintiff may have an action for his whole debt against the sheriff; for, though upon arrests, and what is called mesne process, being such as intervenes between the commencement and end of a suit, the sheriff, till the statute 8 and 9 Will. c. 27, might have indulged the defendant as he pleased, so as he produced him in court to answer the plaintiff at the return of the writ; yet, upon a taking in execution, he could never give any indulgence; for in that case, confinement is the whole of the debtor's punishment, and of the satisfaction made to the creditor. A rescue of a prisoner in execution, either in going to gaol, or in gaol, or a breach of prison, will not excuse the sheriff from being guilty of, and answering for the escape; for he ought to have sufficient force to keep him, seeing he may command the power of the county. In criminal cases, an escape of a person arrested, by eluding the vigilance of his keeper before he is put in hold, is an offence against public justice, and the party himself is punishable by fine and imprisonment; but voluntary escapes amount to the same kind of offence, and are punishable in the same degree as the offence of which the prisoner is guilty, and for which he is in custody, whether treason, felony, or trespass, and this whether he was actually committed to gaol, or only under a bare arrest; but the officer cannot be thus punished, till the original delinquent is actually found guilty or convicted by verdict, confession, or outlawry; otherwise it might happen, that the officer should be punished for treason or felony, and the party escaping turn out to be an innocent man. But before the conviction of the principal party, the officer thus neglecting his duty, may be fined and imprisoned for a misdemeanor. 4 Black. 129.

If any person shall convey, or cause to be conveyed into any gaol, any disguise, instrument, or arms, proper to facilitate the escape of prisoners, attainted or convicted of treason or felony, although no escape or attempt to escape be made, such person so offending, and convicted, shall be deemed guilty of felony, and be transported for seven years. 16 Geo. II. c. 31.

ESCAPEMENT. See SCAPEMENT.

ESCHALOT. See ALLIUM.

ESCHEAT, in our law, denotes an obstruction of the course of descent, and a consequent determination of the tenure, by some unforeseen contingency; in which case, the land naturally results back, by a kind of reversion, to the original grantor or lord of the fee. This happens either for want of heirs of the person last seized, or by his attainder for a crime by him committed; in which latter case, the blood is tainted, stained, or corrupted, and the inheritable quality of it is thereby extinguished.

ESCHEAT, for want of heirs, is where the

tenant dies without any relations on the part of any of his ancestors, or where he dies without any relations of those ancestors, paternal or maternal, from whom his estate descended; or where he dies without any relations of the whole blood. Bastards are also incapable of inheritance; and therefore if there be no other claimant than such illegitimate children, the land shall escheat to the lord; and, as bastards cannot be heirs to themselves, so neither can they have any heirs, but those of their own bodies; and therefore, if a bastard purchase lands, and die seized, without issue and intestate, the land shall escheat to the lord of the fee. Aliens also, that is, persons born out of the King's allegiance, are incapable of taking by descent; and unless naturalized, are also incapable of taking by purchase; and therefore, if there be no natural born subjects to claim, such lands shall in like manner escheat. By attainder for treason or other felony, the blood of the person attainted is corrupted and stained, and the original donation of the feud is thereby determined, it being always granted to the vassal on the implied condition of his well demeaning himself. In consequence of which corruption and extinction of hereditary blood, the land of all felons would immediately revert in the land, but that the superior law of forfeiture intervenes, and intercepts it in its passage; in case of treason, for ever; in case of other felony, for only a year and a day; after which time it goes to the lord in a regular course of escheat. 2 Black. c. 15.

ESCHEATOR was an ancient officer, so called because his office was properly to look to escheats, wardships, and other casualties belonging to the crown. This office having its chief dependance on the courts of wards, is now out of date.

ESCUAGE signifies a kind of knights' service, called service of the shield, whereby the tenant is bound to follow his lord into the Scotch or Welsh wars, at his own expence. He who held a whole knights' fee, was bound to serve with horse and arms 40 days at his own charge, and he who held half a knights' fee was to serve 20 days.

ESCUTCHEON, in heraldry, is derived from the French *escussion*, and that from the Latin *scutum*, and signifies the shield whereon coats of arms are represented. Most nations, of the remotest antiquity, were wont to have their shields distinguished by certain marks painted on them; and to have such on their shields was a token of honour, none being permitted to have them till they had performed some honourable action. The escutcheon, as used at present, is square, only rounded off at the bottom. As to the bearings on shields, they might at first be arbitrary, according to the fancy of the bearer; but, in process of time, they came to be the gift of kings and generals, as the reward of honourable actions.

ESCUTCHEON *of pretence*, that on which a man carries his wife's coat of arms, being an heiress, and having issue by her. It is placed over the coat of the husband, who thereby shews forth his pretensions to her lands.

ESOX, the *pike*, in natural history, a genus of fishes of the order Abdominales. Generic character: head flattish above, mouth and throat large; teeth sharp, in the jaws, palate, and tongue; nostrils double, near the eyes; gill-membrane with from seven to twelve rays; body elongated; dorsal fin near the tail. Gmelin enumerates fifteen species, and Shaw twenty-two: we shall notice the following, as the most important.

E. lucius or the common pike. In Lapland this fish, we are informed, is found not unfrequently of the length of eight feet. It is to be met with in most lakes and small rivers throughout Europe. Its common colour is a pale olive, but in Holland it has been seen of an orange colour with black spots. When in its perfect state its colours are uniformly found to be most vivid. The largest pike ever caught in Great Britain is supposed to have been one which weighed thirty-five pounds. It is a fish of particularly rapid growth, and also of great longevity, having been ascertained, according to one of the natural historians of Poland, to live to the age of ninety years. The stomach of the pike is particularly strong, muscular, and extended. Its teeth, without including those nearest the throat, are no fewer than seven hundred, and those which are placed on the jaws are alternately moveable and fixed. It is one of the most voracious of fishes, and is often found to swallow water-rats and young ducks; it has even attacked the swan, and swallowed the head and great part of the neck of that bird; but being unable to separate these from the body, it became, in this instance, the victim of its voracity. It will engage with the otter in the most ferocious and persevering contests for any article of food, and after long abstinence has been known to seize on the lips of a mule, and to be drawn up by the affrighted

quadruped before it could possess time for extrication. It is not unfrequently caught in the latter end of spring in the ditches near the Thames, while asleep, by means of a noosed cord dexterously slipped round it. The appearance of the pike is dreaded by the smaller fishes, as the signal of destruction, and is observed to excite in them all the indications of detestation and terror.

E. stomias, or the piper-mouthed pike, is a native of the Mediterranean sea, about eighteen inches in length, and of a greenish brown colour. Its lower jaw is considerably longer than the upper; it has two fore teeth in the upper, and these with two of the under, project from the mouth when shut; the first ray of the dorsal fin, which is near the head, is very long and setacious, and its body gradually tapers towards the tail, which is somewhat forked. It is a very curious fish, and a specimen of it is to be seen in the British Museum.

ESPALIERS, in gardening, are rows of trees planted about a whole garden or plantation, or in hedges, so as to inclose quarters or separate parts of a garden; and are trained up regularly to a lattice of woodwork in a close hedge, for the defence of tender plants against the injuries of wind and weather. They are of admirable use and beauty in a kitchen-garden, serving not only to shelter the tender plants, but screen them from the sight of persons in the walks. See GARDENING.

ESPLANADE, in fortification, is the sloping of the parapet of the covered way towards the campaign. It is the same with glacis, and is more properly the empty space between the citadel and the houses of a town.

ESQUIRE was anciently the person that attended a knight in the time of war, and carried his shield. This title has not, for a long time, had any relation to the office of the person, as to carry arms, &c. Those to whom the title of esquire is now of right due, are all noblemens' younger sons, and the eldest sons of such younger sons; the eldest sons of knights, and their eldest sons; the officers of the King's courts, and of his houshold; counsellors at law, justices of the peace, &c. though those latter are only esquires in reputation: besides, a justice of the peace holds this title no longer than he is in commission, in case he is not otherwise qualified to bear it; but a sheriff of a county, who is a superior officer, retains the title of esquire during life, in consequence of the trust once reposed in him; the heads of some ancient families are said to be esquires by prescription.

ESQUIRE, is a name of dignity, next above the common title of gentleman, and below a knight; heretofore it signified one that was attendant, and had his employment as a servant, waiting on such as had the order of knighthood, bearing their shields, and helping him to horse and the like. All Irish and foreign peers, are only esquires in our law, and must be so named in all legal proceedings. Esquires of the King, are such who have the title by creation; these when they are created, have a collar of SS put about their necks, and a pair of silver spurs is bestowed on them; and they were wont to bear before the prince in war, a shield or lance. There are four esquires of the King's body to attend on his Majesty's person.

ESSAY, in metalurgy. See ASSAYING.

ESSENCE, in chemistry, denotes the purest, most subtile, and balsamic part of a body; extracted either by simple expression, or by means of fire, from fruits, flowers, and the like. Of these there are a great variety, used on account of their agreeable smell and taste, by apothecaries, perfumers, and others. Those extracted by means of fire, with more propriety are to be counted among the essential oils.

ESSENCE *of bergamot*, is a fragrant essence, extracted from a fruit which is produced by ingrafting a branch of lemon-tree, upon the stock of a bergamot-pear. It is imported from Italy and Sicily, particularly from Reggia and Messina. This spirit is extracted, by paring off the rind of the fruit with a broad knife, pressing the peel between wooden pincers against a spunge, and as soon as the spunge is saturated, the volatile liquor is squeezed into a phial.

ESSENCE *of orange*, and ESSENCE *of lemon*, are prepared in a similar manner, and come from the same countries.

The essences of lavender, of thyme, of rosemary, of anise, of cloves, of cinnamon, &c. are obtained by means of fire.

ESSENCE, in philosophy, that which constitutes the particular nature of each genus or kind, and distinguishes it from all others; being nothing but that abstract idea to which this name is affixed; so that every thing contained in it, is essential to that particular kind.

ESSENDI *quietum de theolonio*, a writ that lies for citizens and burgesses of any city or town, that have a charter on prescription to exempt them from toll through the whole realm, if it happened to be any where exacted of them.

ESSENES, or ESSENIANS, in Jewish

antiquity, one of the three ancient sects among that people, who outdid the Pharisees in their most rigorous observances. They allowed a future state, but denied a resurrection from the dead. Their way of life was very singular; they did not marry, but adopted the children of others, whom they bred up in the institutions of their sect; they despised riches, and had all things in common; and never changed their clothes till they were entirely worn out. When initiated, they were strictly bound not to communicate the mysteries of their sect to others; and if any of their members were found guilty of enormous crimes, they were expelled.

ESSENTIAL, something necessarily belonging to the essence or nature of a thing, from which it cannot be conceived distinct; thus the primary qualities of bodies, as extension, figure, number, &c. are essential or inseparable from them in all their changes and alterations.

Essential *character*. See Characters.

Essential *oil*, that procured from plants by distillation. See Oil.

Essential *salts*, those obtained from vegetable juices by crystallization. See Salt.

ESSOIN, signifies the allegation of an excuse for him that is summoned, or sought for, to appear and answer to an action real, or to perform suit to a court baron, upon just cause of absence. There are various kinds of excuses which were formerly allowed, but the practice of essoins is obsolete.

ESTABLISHMENT *of dower*, in law, the assurance of dower made to the wife by the husband, or his friends, before or at marriage. Assignment of dower, is the setting it out by the heir afterwards, according to the establishment.

ESTATE, in law, that title or interest which a man hath in lands or tenements, &c. This may be considered in a threefold manner: 1. as to the quantity of interest which the party has; 2. the time when that interest is to be enjoyed; 3. the number and connections of the parties who are to enjoy it.

I. The first is measured by its duration or extent, which may be for an uncertain period, during his own life or the life of another man, to determine at his own decease, or to remain to his descendants after him; or it is for years, months, or days, or infinite and unlimited, being to a man and his heirs for ever. This occasions the division into estates of freehold, and less than freehold. The former is any estate of inheritance or for life, either in a corporeal or incorporeal hereditament, existing in or arising from real property of free tenure; that is now of all which is not copyhold; but tithes and spiritual dues may be freehold, though they issue out of lands not freehold. Freeholds may be considered either as estates of inheritance, or not of inheritance. The former are of inheritance absolute, called fee-simple; or inheritance limited, one species of which is called fee-tail. Limited fees are such estates of inheritance as are clogged with conditions or qualifications, which may be either, 1st. qualified or base fees; or, 2nd. fees conditional. The former is instanced by a grant to A and his heirs, tenants of the manors of Dale, which may continue for ever if the heirs of A still continue tenants of Dale; but being subjected to a condition which lowers or debases the certainty of the tenure, it is called a base fee. For fee-tail, see Fee *tail* in this Dictionary, *et post.* Of estates of freehold for life only some may be called conventional, such as are created by act of the parties, others merely legal or arising by operation of law. For estates for life conventional, see Life *estate*. The latter are tenant in tail after possibility of issue extinct, tenant by the curtesy, and tenant in dower, which see.

Of estates less than freehold there are three sorts: 1. estates for years; 2. at will. See Lease. 3. estates by sufferance. Besides there are some estates upon condition as on mortgage estates by statute merchant; statute staple; elegit; which see.

II. Thus far we consider the quantity of the interest. Secondly, as to the time of their enjoyment, which is present or future, they are divided into estates in possession or expectancy. The latter are divided into estates in remainder and reversion, which lead to very nice and abstruse distinctions. See Remainder, Reversion, Executory Devise, Limitation, &c. On this head, as to the certainty and time of enjoyment, estates are, 1st. vested in possession: 2nd. vested in interest, as reversions; vested remainders; such executory devises, future uses, conditional limitations, &c. as are not referred to or made to depend on a period which is uncertain: 3d. estates contingent which are referred to a condition or event, which is uncertain whether it may happen or not. An estate is vested when there is an immediate fixed right of present or future enjoyment. It is vested in possession when there is a right of present enjoyment; vested in interest where a present

fixed right of future enjoyment. An estate is contingent when a right of enjoyment is to accrue on an event which is uncertain.

III. With respect to the number of owners, estates in all the above three respects may be held by one or amongst many in four ways, in severalty, in joint tenancy, in coparcenary, or in common. Severalty is the holding lands, &c. as the single owner thereof, which is generally implied where nothing more is said; as to the rest, see JOINT TENANTS and PARCENERS. As to the title to estates, see TITLE; and as to TENURE, see that article.

ESTATES are acquired by different ways, as by descent from a father to son, which is distinguished from purchase, conveyance or grant from one to another, by deed or by will; and a fee-simple is the largest possible estate, and by the words, all his estates, in a deed or will, every thing passes which the party has, and therefore this word creates, in a will or estate in fee, without a limitation to the heirs.

ESTATES are divided into real, such as lands, which descend to the heir, and personal, as chattels, which go to the executor.

ESTOPPEL, in law, an impediment or bar of action, arising from a man's own act; or where he is forbidden to speak against his own deed; for by his act or acceptance he may be estopped to speak the truth. There are three kinds of estoppels, *viz.* by matter of record, as by letters patent, fine, recovery, pleading, taking of continuance, confession, imparlance, warrant of attorney, admittance. By matter in writing, deed, &c. or by matter in pais, *i. e.* by some act, such as livery, entry, partition, acceptance of rent, or of an estate. Thus if a man seised in fee takes a lease of his own land, by this he is estopped, or prevented, from claiming the fee during the term.

ESTOVERS, in law, signifies any kind of allowance out of lands; but in general it is a liberty of taking necessary wood for the use or furniture of a house or farm, and this any tenant may take from off the land let or demised to him, without waiting for any leave, assignment, or appointment of the lessor, unless restrained by special covenant to the contrary.

ESTRAYS and WAIFS. Estrays are any valuable beasts, not wild, found within a lordship whose owner is not known; such as are commonly impounded and not claimed. They are then to be proclaimed in the church and two nearest market-towns, on two market-days, and not being claimed by the owner, belong to the King, and now commonly by grant of the crown, to the lord of the manor, or the liberty. Beasts *feræ naturæ*, cannot be estrays. Swans, but no other fowl may be estrays. The estray is not the absolute property of the lord till the year and day, with proclamation; and therefore if it escape from the lord before, to another manor, he cannot reclaim it. If proclamation is neglected, the owner may claim it without paying the expences, and may do so at all times within the year and day, upon paying them; but afterwards it is vested in the lord absolutely. The owner may seize it without telling the marks, or proving the property, till the trial; the lord should demand a sum for the keeping it, and the owner may then tender any reasonable sum, the propriety of which, if it is not received, may be ascertained by the jury upon the trial. Amends may be tendered generally without a particular sum, before the lord fixes the amount. An estray must not be used; but a cow may be milked of necessity. The King's cattle cannot be estrays. The year and day runs from the first proclamation, not the seizure.

Waifs are goods which are stolen, and waved, or left by the felon on his being pursued, for fear of being apprehended; and forfeited to the King or lord of the manor; and though waifs are generally spoken of things stolen, yet if a man be pursued with hue and cry as a felon, and he flies and leaves his own goods, these will be forfeited as goods stolen; but they are properly the fugitive's goods, and not forfeited till it be found before the coroner, or otherwise of record, that he fled for the felony.

ESTREAT, in law, *extractum*, a true copy, or note, of some original writing or record, and especially of fines and amercements, and imposed in the rolls of a court, and extracted or drawn out from thence, and certified into the court of Exchequer, from whence process is awarded to the sheriff to levy them: in order, therefore, to be relieved from any fine or estreat, application is made to that court upon motion.

ESTREPEMENT, in law, *estrepamentum*, from *estropier mutilare*, or *extirpare*, the spoil made by a tenant for life upon any lands or woods, to the prejudice of the reversioner; also a writ, in two cases; the one, when the person having an action depending (as a formedon, writ of right, &c.) for recovery of the possession of land without damages, sues to prohibit the tenant

from making waste during the suit; the other lies after possession is adjudged, but not delivered, and to prevent like waste which is expected. The court of Chancery now grants an injunction, on filing a bill and before answer, to prevent waste, and these writs are disused.

ETHER. The action of the more powerful acids on alcohol, gives rise to an order of compounds of some importance from their peculiar properties. These, as produced by the different acids, vary somewhat in their qualities: they also agree, however, in the possession of certain general properties; they are highly volatile, odorous, pungent, and inflammable, miscible with water, and capable of combining with alcohol, in every proportion. These compounds are named ethers; the specific name of each being derived from the acid, from the action of which on alcohol it has originated, as the sulphuric, nitric, muriatic, or acetic ether.

Sulphuric ether, has been longest known. The following is the process by which it is prepared.

Upon a quantity of alcohol in a retort, (selected thin at the bottom, so as to be capable of bearing a sudden heat,) is poured an equal weight of sulphuric acid, then mixed with the alcohol above by frequent and moderate agitation. From this mixture the alcohol acquires a brownish colour; vapours having a fragrant odour are disengaged; and the temperature rises to about 180 of Farenheit. When the mixture of the acid and alcohol is complete, the retort is to be immediately placed in a sand bath, and connected with two large receivers, which are kept cool, by water or ice. Heat is to be immediately applied to the retort. The liquor boils when the temperature is raised to 208, the ether being formed at that temperature and distilling over: the condensation of it is to be promoted by keeping the receivers cool with water, and the distillation is to be continued till about half the quantity of alcohol employed has distilled over, or until the neck of the retort becomes obscured with white fumes, which condense into a matter of apparently an oily consistence.

The liquor which distils over into the receiver is the sulphuric ether. If, to the residual liquor in the retort, there be added half the quantity of alcohol employed in the first distillation, on applying heat, a new production of ether will take place; and this may be repeated for several times.

Towards the end of the distillation, a portion of sulphurous acid is formed and disengaged, with which the ether is so far impregnated, that its fragrance is injured, and its odour rendered pungent and acrid. A portion of water likewise distils over, by which it is diluted. The liquor in the retort, at the end of the distillation, is also found diluted with a portion of the water; it is however, thick, and of a black colour, from a quantity of carbonaceous matter suspended in it.

From the water and sulphurous acid the ether is freed, by subjecting it to a second distillation with a very gentle heat applied by a water-bath, pure potash being previously added to it, in the proportion of two drachms to each pound; this attracts the sulphurous acid, and renders even the water rather less volatile. Another method of rectification, proposed by Pelletier, ("Memoires de Chimie," tom. i. p. 316.) and revived by Dize, ("Nicholson's Journal," 4to, vol. iii. p. 43,) which Mr. Murray, from whose "System" the present article is extracted, found to succeed extremely well, is to distil the ether of the first distillation from a little black oxide of manganese, the oxygen of which combines with the sulphurous acid, converting it into sulphuric; and this, with the water, remains in the retort. Even after either of these processes, the ether may still contain a portion of alcohol, which usually passes over in the first stage of the distillation. This is best abstracted by agitation with water, which imbibes the alcohol, and a little of the ether: the greater part of the ether floats above, may be drawn off, and by distilling it with a very gentle heat, is obtained extremely pure.

A degree of obscurity still prevails with regard to the theory of the formation of sulphuric ether; different views having been entertained of the agency of the acid on the alcohol. The explanation that was generally given, after the establishment of the theory of Lavoisier, was founded on the supposition, that the acid acts principally by communicating oxygen. Alcohol consists of carbon and hydrogen, with a portion of oxygen: when mixed with sulphuric acid, and exposed to heat, it was supposed that part of the acid suffered decomposition, its oxygen being attracted by the hydrogen of the alcohol, and forming water; the balance of attractions between the principles of the alcohol being thus broken, part of its carbon is precipitated, and is diffused through the liquor, rendering it

thick, and dark coloured; and the remaining quantities of its elements, its carbon, hydrogen, and oxygen, unite and form the ether.

This explanation is founded on the supposition, that the sulphuric acid is decomposed in the process by which ether is formed. But a few years ago it was affirmed by Fourcroy and Vauquelin, from a series of experiments which they undertook to elucidate this subject, that such a decomposition of the acid is not at all necessary to its formation: that although it may take place to a certain extent towards the end of the process, when the liquor is loaded with carbon, there is no indication of it in the first stage, during which, principally, the ether is formed; no sulphurous acid gas is discharged, and if the process be stopped at the end of this stage, the remaining acid, they found, is capable of saturating the same quantity of alkali, as before its mixture with the alcohol. ("Nicholson's Journal," 4to, vol. i. p. 385.)

These chemists gave, therefore a different view of this subject, which they applied even to the action of this acid on vegetable matter in general. They suppose that the sulphuric acid suffers no decomposition, and that it acts no other part than causing, by the exertion of a disposing affinity, the decomposition of the alcohol. By this affinity, it disposes part of the hydrogen and of the oxygen of the alcohol to combine and form water: the balance of attractions being thus subverted, a quantity of carbon is separated, and the remaining carbon, hydrogen, and oxygen, combine and form ether.

This theory, however, advanced by these chemists, is not perhaps perfectly established. Though they affirm, that the acid remaining after the formation of ether, saturates as much alkali as it would do previous to its mixture with the alcohol, the experiment by which this is supposed to be established is not altogether without fallacy. During the formation of ether, there is always, also a formation from the elements of the alcohol, of some of the vegetable acids, particularly of the acetous and oxalic. The oxalic, it has been ascertained by the observation of Cadet, is formed copiously even without heat, merely by allowing the mixture of acid and alcohol to remain at rest for some time. These will contribute to the saturation of the alkali; so that if none of the sulphuric acid were decomposed, more alkali ought in reality to be saturated by it after, than before its mixture with the alcohol.

There are also some facts which appear to prove the necessity of the presence of some substance that can part with its oxygen, for the production of ether. Thus, ether cannot be formed from the muriatic acid, but it can with facility from the oxymuriatic; it is likewise formed with great rapidity by the nitric acid; neither of which can exert a strong disposing affinity to water, though both very readily part with their oxygen.

Whatever opinion, however, may be formed as to the manner in which the changes that take place during the formation of ether are produced, the nature of the changes themselves seems sufficiently well ascertained. It is proved, that a quantity of the hydrogen of the alcohol is expended in the formation of water, as the remaining acid is always in a diluted state: a still larger quantity of carbon is also separated, and is mechanically diffused through the liquor. The ether, therefore, which is the only other product of the operation, is to be considered as a compound of hydrogen, and carbon, and perhaps oxygen; differing from alcohol, in containing a much larger quantity of hydrogen proportioned to its carbon; and to this predominance of hydrogen its great levity and volatility are owing. This conclusion is confirmed, by its analysis by combustion, the products of which are water and carbonic acid; the former being derived from the combination of its hydrogen with the oxygen of the air, the latter from the same combination of its carbon. Mr. Cruickshank found, that the vapour of ether requires about seven times its volume of oxygen to saturate it in combustion; the products being water and carbonic acid gas, the latter amounting to 4.6 parts by measure. From this result, compared with a similar experiment on alcohol, he inferred, that the proportion of carbon to hydrogen in the ether, is as 5 to 1 nearly, while in alcohol it is as 8 or 9 to 1. ("Nicholson's Journal," 4to, vol. v. p. 205.)

Besides ether, there are some other products formed during the action of sulphuric acid upon alcohol. Towards the end of the process an oily-like matter distils over, which has been named Sweet Oil of Wine. This can be obtained separate, by changing the receiver: it is unctuous, thick, and less volatile than the ether, but is soluble both in it and in alcohol. It is obtained like-

wise by distilling sulphuric ether from a fresh quantity of acid. Chemists are not agreed respecting its nature: Fourcroy and Vauquelin consider it as similar to ether, and that it differs from that fluid principally in containing a larger proportion of carbon, which gives to it more density and less volatility. Other chemists, particularly Higgins, have affirmed, that it is a compound of ether and sulphurous acid, and that by the addition of an alkali which combines with the acid, a quantity of ether may be obtained from it. It does not appear, however, that this combination can be formed directly, or that ether can combine with a large quantity of sulphurous acid, so as to assume the properties of oil of wine; and though this substance may contain a portion of this acid, it is not improbable that it also differs from ether in its ultimate composition. At the same time that the oil of wine is disengaged, there is formed a quantity of olefiant gas, which passes off. It was in this process, indeed, that the production of this gas was first observed; and the action of sulphuric acid on alcohol still affords us the best method of obtaining it pure. The same gas is produced, by passing the vapour of ether through an ignited earthen tube; but when a glass tube is used, a different variety of carburetted hydrogen is obtained.

At this stage of the process the liquor becomes so loaded with carbon, and at the same time is capable of bearing so high a temperature, that if the heat is kept up, the sulphuric acid is decomposed, and a large quantity of sulphureous acid gas and carbonic acid is produced. If the greatest care is not taken to keep the heat moderate, the whole liquor is apt to swell suddenly up, and boil over into the receiver. If examined at this time, it is likewise found to contain a portion of acetic and oxalic acids mixed with the sulphuric acid, which is diluted with water, and through which the carbon is diffused. Sulphuric ether, when highly rectified, is the lightest of all known liquids. It is obtained without difficulty of the specific gravity of .732, and by careful distillation has been brought so low as .716. It is colourless, and perfectly transparent; has a strong pungent taste, and a fragrant penetrating smell.

It is likewise the most volatile liquid. It evaporates rapidly, even at the common temperature, and under the common pressure of the atmosphere; so that it cannot be poured from one vessel into another without loss, and any part wet with it immediately becomes dry. In vacuo it boils at a temperature considerably below 32°: under the atmospheric pressure it boils at 98. In the spontaneous evaporation of ether a large quantity of caloric is absorbed, so as to produce cold: water inclosed in a small tube may be easily frozen, by ether evaporating from a piece of muslin wrapt round the external surface of the tube; and Dr. Higgins has observed, that in the rapid evaporation of ether, the temperature in frosty weather falls so low as 40. Ether congeals at 47.

Ether is highly inflammable, and, when kindled, burns with a clear white flame, without any smoke, and without leaving any residuum, the products of its combustion being water and carbonic acid: the residual water generally gives indications too of sulphuric acid, which may either be adventitious, or perhaps is essential to the constitution of this species of ether. From its high inflammability, its vapour diffused in the atmosphere sometimes takes fire; or if a drop or two of ether be added to atmospheric air, or oxygen gas, an explosion happens on the contact of an ignited body.

Sulphuric ether is soluble in water; but only in a limited proportion. When highly rectified, it requires ten parts of water for its solution; and this is a property by which we are enabled to determine its purity, as, if more soluble, it contains either water or alcohol. It is soluble in alcohol in every proportion.

Sulphuric ether exerts no sensible action on the fixed alkalies or earths. It unites with ammonia by distillation.

Neither does it act on the metals; but it is capable of decomposing the saline combinations of those that have a weak affinity to oxygen, by attracting that principle. Thus, muriate of gold dissolved in it is gradually decomposed, and the gold precipitated in its metallic form.

On the simple inflammables its action is somewhat similar to that of alcohol. It dissolves sulphur, as Favre has shewn, one ounce of ether dissolving about 25 grains: the solution has a strong sulphurous smell and taste: it is less soluble in water than pure ether, and deposits sulphur as the ether volatilizes. ("Nicholson's Journal," vol. xiii. p. 69.) Ether likewise dissolves a small proportion of phosphorus: this solution, like the phosphuretted alcohol, is decomposed by water; but does not, like it, appear luminous during the decomposition.

Sulphuric ether is a solvent of many of

the vegetable proximate principles, as the essential oils, camphor, and resins. It is also, as has already been remarked, the most powerful solvent of caoutchouc.

In medicine it is employed as a diffusible stimulant.

Nitric ether. The action of nitric acid on alcohol is so violent, that the formation of nitric ether is extremely difficult, and requires considerable precaution. One part of the acid may be added gradually to three parts of alcohol without any risk; and after standing for some days, to allow of their reciprocal action, heat may be applied, when a portion of nitric ether that has been formed distils over, with a quantity of unchanged alcohol. A preparation of this kind has been long known in pharmacy, under the name of sweet spirit of nitre. But when the proportion of acid is increased the action becomes very violent; a quantity of aërial fluid is suddenly formed, and disengaged at each addition; and it requires particular arrangements to admit of so much acid being added as is sufficient to convert the whole of the alcohol into ether.

The method proposed by Navier is, to put into a strong earthenware bottle twelve parts of alcohol, and immerse it in water or ice; eight parts of nitrous acid are to be added in successive portions, mixing them by agitation at each addition; the bottle is well corked, and tied over, and is put in a cool place. At the end of six days the cork is to be perforated, to allow a quantity of gaseous fluid that has been formed, and is retained by compression, to escape. The bottle is then uncorked, the liquid poured into a funnel, and the acid liquor beneath allowed to run off from the ether which swims above.

An ingenious method, somewhat similar, but less hazardous, was employed by Dr. Black. He first poured into a strong flint glass bottle six ounces of alcohol; then, by a funnel, the tube of which reached to the bottom of the bottle, he poured in two ounces of water gently, so that it did not mix with the alcohol, but raised it above it; and, lastly, he poured in four ounces of nitrous acid in the same manner, so that the small column of water was interposed between it and the alcohol. The phial was set aside for some time in a cool place: the water attracted the alcohol at the one surface, the acid at the other, and thus brought them very gradually together, so as to admit of their reciprocal action without violence. At the end of a few months they were completely mixed, and nitric ether formed, which floated above, was withdrawn and rectified by distillation.

The theory of the formation of nitric ether is as obscure as that of sulphuric ether. It is ascertained, however, that even from the commencement of the process the acid is decomposed; nitric oxide gas is disengaged; and Pelletier found that the decomposition was complete, nitric acid not being discoverable, either in the liquor which passed over, or in the residuum.

It is also proved, that in the formation of nitric ether the alcohol suffers decomposition, as in the residual liquor oxalic and acetic acids are formed. There is no deposition, however, of carbonaceous matter, as there is in the formation of sulphuric ether, the residual liquor being quite transparent, and of a light colour. It appears to follow, therefore, from these facts, that in the formation of nitric ether part of the elements of the alcohol combine with oxygen from the nitric acid, and form oxalic and acetic acids; carbonic acid gas too is formed and disengaged, as Pelletier found, in considerable quantity, and much of the nitric acid mixed with nitric oxide and nitrogen gases. (Mémoires de Chimie, tom. i. p. 138.)

It is difficult, however, to determine in what manner these facts are to be combined, so as to give with precision the theory of the formation of nitric ether: nor is it very apparent, whether any of the elements of the nitric acid enter into its composition, or whether they are entirely disengaged during the process. It might be supposed, that it must contain more carbon than sulphuric ether, as none is deposited during its formation; but we are not certain what quantity is carried off in the state of carbonic acid.

Nitric ether has some resemblance in its properties to sulphuric ether. Like it, it is light and volatile, and has been said, when highly rectified, to have these qualities even in a higher degree than sulphuric ether. It is also inflammable, burns with an enlarged flame, and is said to deposit more charcoal. It is soluble in water and in alcohol. Its odour is strong, though scarcely so agreeable as that of sulphuric ether; in the state, however, of what has been named dulcified spirit of nitre, it is more fragrant. Its colour is usually yellow; but this, as well probably as some of its other qualities, appears rather to be owing to the presence of ni-

tric acid, surcharged perhaps with nitric oxide.

Muriatic ether. Pelletier proposes the following process to form muriatic ether: place a retort in a sand-bath, and connect it with a glass balloon, and two of Woulfe's bottles: put into the bottle 100 parts of muriate of soda, perfectly dry, and into the balloon and bottles the same quantity of alcohol. The joinings being luted, 50 parts of sulphuric acid are to be poured on the salt, and the operation is left to proceed in the cold for five or six hours. A moderate heat is then to be gradually applied. The muriatic acid gas passes over, and is condensed by the alcohol. The whole of this liquor is then put into a retort, with twenty parts of oxide of manganese in fine powder; and there is put into the receiver and bottles a solution of pure potash. It is distilled by a gentle heat; the muriatic ether passes over, and the re-action of any excess of oxymuriatic acid gas upon it, which would change it to oil, is prevented by the alkali. The ether is then to be rectified, by mixing it with twice its bulk of water, and distilling it by a very gentle heat.

The properties of muriatic ether have not been properly described, from the difficulty of obtaining it pure. It is said to be light, transparent, volatile, and inflammable, emitting while burning a pungent odour, and to have a styptic taste.

A process has been given by Boudet for the preparation of *phosphoric ether.* He mixed liquid phosphoric acid of a thick consistence and alcohol in equal proportions, introduced the mixture into a tubulated retort connected with a receiver, and with an Woulfe's bottle, which was filled two-thirds with lime-water: heat was applied, so as to cause the mixture to boil; a portion of unchanged alcohol first distilled over; this was succeeded by a liquor having an ethereal odour, mixed a little with that of garlic: it reddened slightly the syrup of violets: when rectified by distillation, with the addition of carbonate of magnesia, the product was colourless, and had an odour somewhat similar to that of sulphuric ether: it was volatile, and highly inflammable, its combustion not being accompanied with any smoke. It floated on the surface of water, but by agitation with it was dissolved. It dissolved the volatile oils, and also phosphorus. Its specific gravity was inferior to that of alcohol, being as 94 to 100. After its production, when the heat was much raised, a quantity of oily matter was distilled over, and carburetted hydrogen was disengaged. The residual liquor was of a dark brown colour, and contained a large quantity of phosphoric acid. (Annales de Chimie, tom. xi. p. 123.)

Fluoric ether has been said to be formed by putting fluate of lime, previously ignited and in powder, into a retort, with equal weights of alcohol and sulphuric acid, and distilling to dryness. The product of this distillation was again distilled to one half, and a portion of fluoric acid abstracted from it by a solution of potash, which at the same time precipitated a portion of silex, so as to render the whole gelatinous. This, on being again distilled, afforded an ether of the specific gravity of 0.720, which burnt with a blue flame, and had a bitter taste. It is added, that it greatly resembled sulphuric ether; and it is not improbable that it may have been merely this ether disguised. (Nicholson's Journal, vol. viii. p. 143.)

Acetic ether has been known for a considerable time to chemists, Lauragais having given, in 1759, the process for preparing it, by distilling alcohol, with the concentrated acetic acid that is procured by the decomposition of acetate of copper by heat. Scheele, as well as other chemists, have been unable to form it; but Pelletier has observed, that it is procured with certainty by distilling alcohol repeatedly from the acetic acid. The alcohol at first acquires an ethereal odour, but is miscible with water; by returning it on the residual liquor, distilling it, and repeating this for a third time, this becomes stronger: the acid contained in the liquor thus procured was saturated by the addition of carbonate of potash; and by distillation there was procured from it a pure acetic ether, in quantity about half of the alcohol employed. ("Mémoires de Chimie," tom. i. p. 237.) It was soluble in water in a limited quantity, seven measures dissolving three. It has an agreeable odour, ethereal, but in which the smell of acetic acid is also perceptible. It is very volatile and inflammable: it burns with a clear light, and leaves a little charcoal.

According to Pelletier, acetic ether may likewise be formed by distillation, from a mixture of sulphuric acid, acetate of copper, and alcohol; and, according to Laplanche, it may be obtained from a mixture of sulphuric acid, alcohol, and acetate of lead.

Ether *of Sir Isaac Newton.* When we have separated the actions of bodies upon

each other, so far that the effects appear to us to be simple, we resolve the causes of motion into two; namely, a disposition of bodies to come together, called attraction, and a disposition to recede from each other, called repulsion. Impulse, or the communication of motion by apparent contact, will not constitute a peculiar case, because we know that bodies cannot be, or are not in any of our observations, brought close to each other. But as in all our philosophising we endeavour to simplify the general principles, it becomes a question, whether the effects of attraction and repulsion may not depend upon the same cause; and as we have many gross instances of bodies being urged together by the action of fluids, it naturally occurs to enquire, whether the apparent attractions in nature may not be caused by some fluid medium. Sir Isaac Newton was strongly of this opinion, as appears by his letter to Boyle, published in Birch's life of that philosopher, as well as by the famous paragraph at the end of his "Principia," and one of the queries at the end of his "Optics," in the preface to the second edition of which he remarks, that he does not take gravity for an essential property of bodies. In the query here mentioned, he proceeds upon the supposition of an elastic medium, pervading all space; a supposition which he advances with considerable confidence, and which he supports by very strong arguments, deduced as well from the phenomena of light and heat, as from the analogy of the electric and magnetic influences. This medium he supposes to be much rarer within the dense bodies of the sun, the planets, and the comets, than in the empty celestial spaces between them, and to grow more and more dense at greater distances from them, so that all these bodies are naturally forced towards each other by the excess of pressure.

The effects of gravitation might be produced by a medium thus constituted, if its particles were repelled by all material substances, with a force decreasing like other repulsive forces, simply as the distances increase; its density would then be every way such as to produce the appearance of an attraction varying like that of gravitation: such an ethereal medium would therefore have the advantage of simplicity, in the original law of its action, since the repulsive force which is known to belong to all matter, would be sufficient, when thus modified, to account for the principal phenomena of attraction.

It may be questioned, whether a medium capable of producing the effects of gravitation in this manner, would also be equally susceptible of those modifications which we have supposed to be necessary for the transmission of light: in either case it must be supposed to pass through the apparent substance of all material bodies, with the most perfect freedom, and there would, therefore, be no occasion to apprehend any difficulty from a retardation of the celestial motions; the ultimate impenetrable particles of matter, being perhaps scattered as thinly through its external form, as the stars are scattered in a nebula, which has still the distant appearance of an uniform light, and of a continuous surface: and there seems no reason to doubt the possibility of the propagation of an undulation through the Newtonian medium, with the actual velocity of light. It must be remembered that the difference of its pressure is not to be estimated from the actual bulk of the earth, or any other planet alone, but from the effect of the sphere of repulsion of which that planet is the centre; and we may then deduce the force of gravitation from a medium of no very enormous elasticity.

A similar combination of a simple pressure with a variable repulsion, is also observable in the force of cohesion; and Dr. Young, in his Lectures, remarks, that supposing two particles of matter floating in such an elastic medium, capable of producing gravitation, to approach each other, their mutual attraction would at once be changed from gravitation to cohesion, upon the exclusion of the portion of the medium intervening between them: this supposition is, however, as he adds, directly opposite to that which assigns to the elastic medium the power of passing freely through all the interstices of the ultimate atoms cohering in this manner; but that, as we see some effects so nearly resembling them, which are unquestionably produced by the pressure of the atmosphere, we can scarcely avoid suspecting that there must be some analogy in the causes.

Two plates of metal, which cohere enough to support each other in the open air, will often separate in a vacuum. When a boy draws along a stone by a piece of wet leather, the pressure of the atmosphere seems to be materially concerned. The well-known experiment, of the two exhausted hemispheres of Magdeburg, affords a still more striking instance of apparent cohesion derived from atmospherical pressure; and

if we place between them a thick ring of elastic gum, we may represent the natural equilibrium between the forces of cohesion and of repulsion; for the ring would resist any small additional pressure with the same force as would be required for separating the hemispheres, so far as to allow it to expand in an equal degree; and at a certain point the ring would expand no more, the air would be admitted, and the cohesion destroyed, in the same manner as when a solid of any kind is torn asunder.

But all suppositions founded on these analogies must be considered as merely conjectural; and our knowledge of every thing which relates to the intimate constitution of matter, partly from the intricacy of the subject, and partly for want of sufficient experiments, is at present in a state of great uncertainty and imperfection.

ETHICS, or MORALITY, the science of manners or duty, which it traces from man's nature and condition, and shews to terminate in his happiness; or, in other words, it is the knowledge of our duty and felicity, or the art of being virtuous and happy. See MORAL PHILOSOPHY.

ETHULIA, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: receptacle naked; down none. There are six species,

ETYMOLOGY, that part of grammar which considers and explains the origin and derivation of words, in order to arrive at their first and primary signification, whence Quintilian calls it *originatio*. See GRAMMAR.

EVAPORATION, in natural philosophy, is the conversion of water into vapour, which in consequence of becoming lighter than the atmosphere, is raised considerably above the surface of the earth, and afterwards by a partial condensation forms clouds. It differs from exhalation, which is properly a dispersion of dry particles from a body. When water is heated to 212°, it boils, and is rapidly converted into steam; and the same change takes place in much lower temperatures; but in that case the evaporation is slower, and the elasticity of the steam is smaller. As a very considerable proportion of the earth's surface is covered with water, and as this water is constantly evaporating and mixing with the atmosphere in the state of vapour, a precise determination of the rate of evaporation must be of very great importance in meteorology. Accordingly, many experiments have been made to determine the point by different philosophers. No person has succeeded so completely as Mr. Dalton: but many curious particulars had been previously ascertained by the labours of Richman, Lambert, Watson, Saussure, De Luc, Kirwan, and others. From these we learn that, 1. the evaporation is confined entirely to the surface of the water: hence it is in all cases proportional to the surface of the water exposed to the atmosphere. Much more vapour of course rises in maritime countries, or those interspersed with lakes, than in inland countries. 2. Much more vapour rises during hot weather than during cold: hence the quantity evaporated depends in some measure upon temperature. The precise law has been happily discovered by Mr. Dalton, who says, in general, the quantity evaporated from a given surface of water per minute at any temperature, is to the quantity evaporated from the same surface at 212°, as the force of vapour at the first temperature is to the force of vapour at 212°. Hence, in order to discover the quantity which will be lost by evaporation from water of a given temperature, we have only to ascertain the force of vapour at that temperature. Hence, we see that the presence of atmospheric air obstructs the evaporation of water; but this evaporation is overcome in proportion to the force of the vapour. Mr. Dalton ascribes this obstruction to the *vis inertiæ* of air. 3. The quantity of vapour which rises from water, even when the temperature is the same, varies according to circumstances. It is least of all in calm weather, greater when a breeze blows, and greatest of all with a strong wind. Mr. Dalton has given a table that shews the quantity of vapour raised from a circular surface of six inches in diameter in atmospheric temperatures. The first column expresses the temperature; the second the corresponding force of vapour; the other three columns give the number of grains of water that would be evaporated from a surface of six inches in diameter in the respective temperatures, on the supposition of there being previously no aqueous vapour in the atmosphere. These columns present the extremes, and the mean of evaporation likely to be noticed, or nearly such; for the first is calculated upon the supposition of 35 grains loss per minute, from the vessel of $3\frac{1}{2}$ inches in diameter; the second 45, and the third 55 grains per minute. 4.

Such is the quantity of vapour which would rise in different circumstances, on the supposition that no vapour existed in the atmosphere. But this is a supposition which can never be admitted, as the atmosphere is in no case totally free from vapour. Now, when we wish to ascertain the rate at which evaporation is going on, we have only to find the force of the vapour already in the atmosphere, and subtract it from the force of vapour at the given temperature; the remainder gives us the actual force of evaporation; from which, by the table, we readily find the rate of evaporation. Thus, suppose we wish to know the rate of evaporation at the temperature 59°. From the table, we see that the force of vapour at 59° is 0.5, or $\frac{1}{60}$ its force at 212°. Suppose we find by trials, that the force of the vapour already existing in the atmosphere is 0.25, or the half of $\frac{1}{60}$. To ascertain the rate of evaporation, we must subtract the 0.25 from 0.5; the remainder 0.25 gives us the force of evaporation required; which is precisely one half of what it would be if no vapour had previously existed in the atmosphere. 5. As the force of the vapour actually in the atmosphere, is seldom equal to the force of vapour of the temperature of the atmosphere evaporation, with a few exceptions, may be considered as constantly going on. Various attempts have been made to ascertain the quantity evaporated in the course of a year; but the difficulty of the problem is so great, that we can expect only an approximation towards a solution.

The most exact set of experiments on the evaporation from the earth, was made by Mr. Dalton and Mr. Hoyle, during 1796, and the two succeeding years. The method which they adopted was this: having got a cylindrical vessel of tinned iron, ten inches in diameter, and three feet deep, there were inserted into it two pipes turned downwards for the water to run off into bottles: the one pipe was near the bottom of the vessel, the other was an inch from the top. The vessel was filled up for a few inches with gravel and sand, and all the rest with good fresh soil. It was then put into a hole in the ground, and the space around filled up with earth, except on one side, for the convenience of putting bottles to the two pipes; then some water was poured on to sodden the earth, and as much of it as would, was suffered to run through without notice, by which the earth might be considered as saturated with water. For some weeks the soil was kept above the level of the upper pipe, but latterly it was constantly a little below it, which precluded any water running off through it. For the first year the soil at top was bare; but for the two last years it was covered with grass, the same as any green field. Things being thus circumstanced, a regular register was kept of the quantity of rain water that ran off from the surface of the earth through the upper pipe, (whilst that took place), and also of the quantity of that which sunk down through the three feet of earth, and ran out through the lower pipe. A rain gauge of the same diameter was kept close by to find the quantity of rain for any corresponding time. The weight of the water which ran through the pipes, being subtracted from the water in the rain-guage, the remainder was considered as the weight of the water evaporated from the earth in the vessel. From these experiments it appears, that the quantity of vapour raised annually at Manchester is about 25 inches. If to this we add five inches for the dew with Mr. Dalton, it will make the annual evaporation 30 inches. Now, if we consider the situation of England, and the greater quantity of vapour raised from water, it will not surely be considered as too great an allowance, if we estimate the mean annual evaporation over the whole surface of the globe at 35 inches. Now, 35 inches from every square inch, on the superficies of the globe, make 94,450 cubic miles, equal to the water annually evaporated over the whole globe. Was this prodigious mass of water all to subsist in the atmosphere at once, it would increase its mass by about a twelfth, and raise the barometer nearly three inches: but this never happens; no day passes without rain in some part of the earth; so that part of the evaporated water is constantly precipitated again. Indeed it would be impossible for the whole of the evaporated water to subsist in the atmosphere at once, at least in the state of vapour. See Manchester Memoirs.

EUCALYPTUS, in botany, a genus of the Icosandria Monogynia class and order. Essential character: calyx superior, permanent, truncate, before flowering time covered with a hemispherical, deciduous lid; corolla none; capsules four-celled, opening at the top, inclosing many seeds. There are two species, *viz.* E. obliqua; oblique leaved eucalyptus, and E. resinifera; red gum tree. These are both very large and lofty trees, much exceeding the English oak both in height and bulk. E. resinifera, con-

tains a large quantity of resinous gum; the wood is of a brittle quality; the flowers grow in little clusters, or rather umbels, about ten in each, and every flower has its proper partial foot stalk, a quarter of an inch in length, besides the general one; the flowers are yellowish, and of a singular structure; the calyx is hemispherical, perfectly entire on the margin, it afterwards becomes the capsule; the anthers are small and red, in the centre is a single style terminated by a blunt stigma; the stamens are resinous and aromatic; the germ appears when cut across to be divided into three cells; each containing the rudiments of one or more seeds.

EUCLEA, in botany, a genus of the Dioecia Dodecandria, or Polygamia class and order. Essential character: male calyx, four or five-toothed; corolla four or five-parted; stamens twelve to fifteen: female calyx and corolla as in the male; germ superior; styles two; berry two-celled. There is but one species, *viz.* E. racemosa; round-leaved euclea, a native of the Cape of Good Hope.

EUCLID, of Megara, a celebrated philosopher and logician; he was a disciple of Socrates, and flourished about 400 years before Christ. The Athenians having prohibited the Megarians from entering their city, on pain of death, this philosopher disguised himself in women's clothes to attend the lectures of Socrates. After the death of Socrates, Plato and other philosophers went to Euclid at Megara, to shelter themselves from the tyrants who governed Athens. This philosopher admitted but one chief good; which he at different times called God, or the Spirit, or Providence.

Euclid, the celebrated mathematician, according to the account of Pappus and Proclus, was born at Alexandria, in Egypt, where he flourished and taught mathematics, with great applause, under the reign of Ptolemy Lagos, about 280 years before Christ. And here, from his time, till the conquest of Alexandria by the Saracens, all the eminent mathematicians were either born or studied; and it is to Euclid, and his scholars, we are beholden for, Eratosthenes, Archimedes, Apollonius, Ptolemy, Theon, &c. &c. He reduced into regularity and order all the fundamental principles of pure mathematics, which had been delivered down by Thales, Pythagoras, Eudoxus, and other mathematicians before him, and added many others of his own discovering: on which account it is said he was the first who reduced arithmetic and geometry into the form of a science. He likewise applied himself to the study of mixed mathematics, particularly to astronomy and optics.

His works, as we learn from Pappus and Proclus, are the Elements, Data, Introduction to Harmony, Phenomena, Optics, Catoprics, a Treatise of the Division of Superficies, Porisms, Loci ad Superficiem, Fallacies, and four books of Conics.

The most celebrated of these is the first work, the "Elements of Geometry;" of which there have been numberless editions, in all languages; and a fine edition of all his works now extant, was printed in 1703, by David Gregory, Savilian Professor of Astronomy at Oxford.

The "Elements," as commonly published, consist of fifteen books, of which the two last, it is suspected, are not Euclid's, but a comment of Hypsicles of Alexandria, who lived 200 years after Euclid. They are divided into three parts, *viz.* The Contemplation of Superficies, Numbers, and Solids; the first four books treat of planes only; the fifth of the proportions of magnitudes in general; the sixth of the proportion of plane figures; the seventh, eighth, and ninth give us the fundamental properties of numbers; the tenth contains the theory of commensurable and incommensurable lines and spaces; the eleventh, twelfth, thirteenth, fourteenth, and fifteenth treat of the doctrine of solids.

There is no doubt but, before Euclid, elements of geometry were compiled by Hippocrates of Chius, Eudoxus, Leon, and many others, mentioned by Proclus, in the beginning of his second book; for he affirms, that Euclid new ordered many things in the Elements of Eudoxus, completed many things in those of Theatetus, and besides strengthened such propositions as before were too slightly, or but superficially established, with the most firm and convincing demonstrations.

History is silent as to the time of Euclid's death, or his age. He is represented as a person of a courteous and agreeable behaviour, and in great esteem and familiarity with King Ptolemy; who once asking him whether there was any shorter way of coming at geometry than by his Elements, Euclid, as Proclus testifies, made answer, that there was no other royal way or path to geometry.

EUCOMIS, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Asphodeli, Jus-

sieu. Essential character: corolla inferior, six-parted, permanent, spreading; filaments united at the base into a nectary growing to the corolla. There are four species, all natives of the Cape.

EUDIOMETRY. The measurement of the quantity of oxygen contained in atmospheric air, or indeed in any gas in which it is not intimately combined, is named eudiometry, and the instrument by which it is performed, the eudiometer. To attain such a measurement, it is merely necessary to present to atmospheric air, some substance which combines with its oxygen, and which either does not afford any gaseous product, or affords one that is easily abstracted and measured. Different substances have been applied to this purpose.

The fluid originally employed by Scheele, in the analysis of the air, the solution of sulphuret of potash, or what is rather more convenient, the sulphuret of lime, is perhaps superior in accuracy to any, at least if the air be not too long exposed to it, and be not in too small quantity proportioned to the quantity of fluid. Phosphorus is applied by a very simple apparatus, but by its solubility in nitrogen gas, it adds to the bulk of the residual air, for which a correction must be made. Nitrous gas was employed by Priestley, it exhibits the result immediately, but is liable to several sources of fallacy. Hydrogen gas was employed by Volta: a given measure of it being put along with a quantity of the air, designed to be submitted to trial, into a graduated tube, and inflamed by the electric spark, the diminution of volume indicating the quantity of oxygen; 100 measures of oxygen require rather less than 200 measures of hydrogen for saturation; about 40 measures of hydrogen are therefore sufficient to saturate the oxygen contained in 100 measures of atmospheric air, but it is proper to use an excess of hydrogen, as otherwise part of the oxygen is liable to escape combination. From 60 of hydrogen, with 100 of atmospheric air, Mr. Dalton states, that the residuum after explosion is 100, 21 of oxygen combining with 39 of hydrogen. The method is simple and expeditious, and as Humboldt and Gay Lussac have remarked, has the great advantage, from the bulk of the mixture, and the great diminution of volume, from the consumption of a given quantity of oxygen, of being more delicate than any other. It also requires no corrections for variations of temperature or atmospheric pressure; and any impurity in the hydrogen gas, which it has been supposed might be a source of error, may be avoided by care. It affords also the best method of determining the purity of oxygen gas, or the proportion of oxygen in any mixed gas containing it. Humboldt and Gay Lussac, in an elaborate memoir, have pointed out all the circumstances to be attended to in employing it as an eudiometer. (Journal de Physique, t. lx. p. 129.)

From the practice of eudiometry, it was at one time expected, as the name implies, that we should be able to ascertain the purity of the air, with regard to its salutary or noxious power on life. It was soon found, however, particularly by Priestley, (and the fact has also since been established by De Marti), that the air of places the most offensive and unhealthy, afforded as much oxygen as that of others of an opposite description; the air, for example, of crowded cities, of low, damp situations, or of crowded manufactories, has not been found less pure than that of the country; the noxious quality of the air depending not so much on any deficiency of oxygen, as on the presence of effluvia not discoverable by this test.

It was at one time imagined, that the composition of atmospheric air is not uniform, but that it varies both at different parts of the earth's surface, and still more at different heights. Ingenhouz made a number of experiments to prove the former fact, from which he concluded, that the air is purer, or contains more oxygen at sea than on land, and that in the neighbourhood of marshy situations it contains less oxygen than the standard. (Philosophical Transactions, vol. lxx. p. 354).

Saussure made some experiments on the air at some of the elevated parts of the Alps, the summit of the great St. Bernard, the Buet, &c.; in this air the proportion of oxygen was less than in the air on the plains. (Voyages, t. ii. p. 357; t. iv. p. 451.)

Von Humboldt relates also, that air brought from a great height in the atmosphere, by a person who had ascended in a balloon, contained in 100 parts 25.9 of oxygen, while air at the surface contained 27.6; and that at the summit of the Peak of Teneriffe, the proportion of oxygen amounted only to 19, while at the foot of the mountain it was 27. The proportions which he states prove sufficiently the error of the eudiometrical method he employed, and the eudiometer he did use, that with nitrous gas, corrected by trying its purity with sul-

plate of iron, is indeed the one which is most liable to fallacy. The analysis of the air in the upper regions of the atmosphere, has since been executed with accuracy by Gay Lussac, assisted by Thenard. A glass balloon was filled with air, at the height of 21,735 feet from the surface, the greatest which has yet been reached, and when opened under water by Gay Lussac after his descent, one half of its capacity was filled by the water, a sufficient proof that it had been accurately closed. The air was subjected to trial, both by Volta's eudiometer, and by the solution of sulphuret of potash; it afforded by the former method 21.49 of oxygen, in 100; by the latter 21.63. Atmospheric air at the surface, analysed at the same time in the eudiometer of Volta, gave precisely the same result, 21.49. (Nicholson's Journal, vol. x. p. 286).

Saussure, junior, also found, that the air on the summit of the Col-du-Geant contained within one-hundredth part as much oxygen as that on the plain, and even this difference may be ascribed to the difficulty of making the experiment with perfect accuracy. The uniformity of the composition of the atmosphere at different parts of the earth's surface, appears also to be established.

Mr. Cavendish originally observed, that air subjected to examination at different times, and air likewise from different places, was of perfectly similar composition; (Philosophical Transactions, vol. lxxiii. p. 129) and the same observation had been made by Fontana, from his own experiments. (Philosophical Transactions, vol. lxix.)

Mr. Davy states, that no sensible difference was found in the air sent from the coast of Guinea, and the air in England. (Journal of the Royal Institution, vol. i. p. 48).

Berthollet found, that the air in Egypt and in France was similar, affording 22 of oxygen in the 100, any difference observed not amounting to a two-hundredth part of the air submitted to trial. (Memoirs relative to Egypt, p. 326).

De Marti, by experiments in Spain, obtained the same uniformity of composition between 21 and 20 of oxygen in the hundred parts) in the air at places at a distance from each other; and he adds also, as established by his experiments, that in every state of the atmosphere, whether with regard to temperature, to pressure, as indicated by the barometer, to winds, to humidity, to the season of the year, or the hour of the day or night, the results were precisely the same. (Journal de Physique, t. iii. p. 173). And more lately the researches of Humboldt and Gay Lussac, made with the view of determining this question, have establish the same conclusion. (Journal de Physique, t. lx. p. 152).

The instruments for subjecting atmospheric air to such changes as may indicate its proportion of oxygen, have been called eudiometers. When a mixture of nitrous gas is to be made with atmospheric air, the most convenient apparatus consists in a glass tube closed at top, and graduated by a diamond into cubic inches and parts. The lower aperture may be widened, in order that the gases may more easily be passed up, and likewise to afford the facility of its standing alone upon the pneumatic shelf. It is likewise usual and advantageous to fit a stopper in the mouth by grinding; a cubic inch measure will be required for determining the quantities poured up. A bottle will do for this purpose, and the instrument may be made very well by a chemist who is obliged to work for himself; by taking any small bottle whatever, and pouring its contents of water, by successive times, into the tube placed mouth upwards. By this means he will obtain a graduation, which, whether of the cubic inch or not, will answer the purposes of eudiometry.

When air is to be exposed to a liquid sulphuret, which absorbs the oxygen, the eudiometric tube may be immersed in the liquid. Professor Hope, of Edinburgh, has contrived a very simple, elegant, and accurate apparatus for this purpose, announced in "Nicholson's Journal," iv. 210. It consists of a small bottle, of the contents of about three ounces, intended to contain the eudiometric liquid; into the neck a tube is accurately fitted by grinding, which holds precisely a cubic inch, and is divided into a hundred equal parts, and on one side the bottle, near its bottom, there is a neck into which a stopper is ground in the usual manner. In the use of this apparatus, the bottle is first filled with the liquid employed, which is best prepared by boiling a mixture of quick lime and sulphur with water, filtering the solution, and agitating it for some time in a bottle half filled with common air. The tube, filled with the gas under examination, or with common air, if that be the subject of the experiment, is next put into its place, and, on inverting the instrument, the gas ascends into the bottle, where it is brought extensively into contact with the

liquid, by brisk agitation. An absorption of oxygen, if present, ensues, and to supply its place, the stopper in the side of the bottle is opened under water, a quantity of which rushes into the bottle; the stopper is then replaced under water, the agitation renewed, and these operations are alternately performed, till no farther diminution takes place; the tube is then withdrawn, while the neck of the bottle is under water, and after the tube has been kept in this situation for a few minutes, the quantity of the diminution will be seen by the graduated scale upon the tube.

Tubes fitted up for exploding a mixture of hydrogen, or other inflammable gases, with oxygen gas, have been called the eudiometers of Volta; they are usually made very strong, and are provided with two wires, which pass through sockets cemented in holes drilled through the glass, near the top, which is not perforated. The electric spark being passed between these wires, gives fire to the gases, not without some risk of blowing out the confining liquid, or breaking the glass.

EVEN *number*, in arithmetic, that which can be divided into two equal parts: such are 4, 10, 40, &c. A number is said to be evenly even, when being even itself, it is measured by an even one, an even number of times: such is 32, as being measured by the even number 8, an even number of times 4. Evenly odd number is, that which an even number doth measure by an odd one: such is 30, which 2 or 6, both even numbers, do measure by 15 or 5, odd ones.

EVERGREEN, in gardening, a species of perennials which continue their verdure, leaves, &c. all the year: such are hollies, phillyria's, laurustinus's, bays, pines, firs, cedars of Lebanon, &c.

EVERLASTING *pea*, the name of a perennial plant of the vetch kind, which grows naturally in some places, is easily cultivated, annually yields plenty of excellent provender, and may be cultivated to advantage as green food for cattle, on almost any strong soil.

EVES *droppers*, or EAVES *droppers*, persons who listen under walls or windows, or the eaves of a house, by night or day, to hear news, and to carry them to others to cause strife among neighbours; and who may be presented at the leet, or bound to their good behaviour, and punished by stat. Westminster, 1. c. 33.

EUGENIA, in botany, so named in honour of Prince Eugene of Savoy, a genus of the Icosandria Monogynia class and order. Natural order of Hesperideæ. Myrti, Jussieu. Essential character: calyx four-parted, superior; petals four; drupe one-seeded, four-cornered. There are eleven species. These are trees or shrubs, all natives of the East or West Indies. The flowers are borne on peduncles, proceeding either from the axils or ends of the branches, singly or many together, in a trichotomous structure.

EVIDENCE, in law, proof by testimony of witnesses on oath, or by writings, or records adduced before a court, or magistrate of competent jurisdiction. It is two-fold, either written or verbal; the former by records, deeds, bonds, or other written documents, the latter by witnesses examined *viva voce*, and called technically, parole evidence. It is also either absolute or presumptive; and may be that which is given in proof by the parties, or which the jury know of themselves, for every thing which makes a fact or thing evident to them, is called evidence.

The system of evidence adopted in our courts, is very comprehensive and refined. The first rule is, that the affirmative of the issue, or matter brought in question by the proceedings, shall be proved; for a negative, generally speaking, cannot be proved, at least, without such circuity, as renders it almost impossible. Where a man is charged with not doing an act, which by law he is required to do, however, this requires some exception, but even then, some evidence is given to prove it. No evidence not relating to the issue, or in some manner connected with it, can be received; nor can the character of either party, unless put in issue by the very proceeding itself, be called in question. The most general and fundamental principle is, that the best evidence the nature of the cause will admit shall be produced; for if better evidence might have been adduced, its being withheld furnishes a suspicion adverse to the party in whose power it was to produce it. So that of a written contract in the custody of the party, no parole evidence can be received as to its contents. But if a deed be burnt, or destroyed by accident, upon positive proof of that fact, other evidence may be given of its contents, and it need not be produced.

Witnesses are summoned by writ of subpœna, to attend on penalty of 100*l.* to the King, and 10*l.* to the party, by statute 5 Eliz. c. 9. besides damages sustained by

their non-attendance. All witnesses of all religions, who believe in a future state of rewards and punishments are received, but not persons infamous in law by their crimes, nor persons directly interested in the matter in issue; and no counsel or attorney shall be compelled to disclose the secrets intrusted to him by his client, but he may give evidence of facts which he knew by other means than for the purpose of the cause. One witness is sufficient to any fact, except in high treason, when by statutes 1 Edw. VI. c. 12, and 5, and 6 Edw. VI. c. 11, two are required, but that is only in treasons of conspiracy against the state, and not treasons relating to the coin, &c. The oath of the witness is to speak the truth; the whole truth, and nothing but the truth, and all evidence is to be given in open court.

The general rules of evidence are, 1. The best evidence must be given that the nature of the thing is capable of. 2. No person interested in the question can be a witness, but to this there are exceptions, as first, in criminal prosecutions; secondly, for general usage, for convenience of trade, as a servant to prove the delivery of goods, though it tends to clear himself of neglect. 3. Where the witness acquires the interest by his own act, after the party who calls him has a right to his evidence. The third rule is, that hearsay of a matter of fact is no evidence; but of matter of reputation, such as a custom, it is in some sort evidence. 4. Where a general character is the matter in issue, particular facts may be received in evidence, but not where it occurs incidentally. 5. In every issue the affirmative is to be proved. 6. No evidence need be given of what is agreed, or not denied upon the pleadings.

In criminal cases the same rules prevail, but evidence of the confessions of the party should be received with caution, and are rejected when obtained through promises or threats. Presumptive evidence should be admitted with caution, and two excellent rules are given by Sir Matthew Hale, that no one should be convicted of stealing goods of a person actually unknown, unless there is proof of a felony actually committed; and none tried for murder, until the murdered body be found.

Written evidence has been divided into two classes: the one, that which is public, the other private; and this first, has been subdivided into matters of record, and others of an inferior nature. The memorials of the legislature, such as acts of parliament, and other proceedings of the two houses, where acting in a legislative character; and judgment of the King's superior courts of justice, are denominated records, and are so respected by the law, that no evidence whatsoever can be received in contradiction of them; but these are not permitted to be removed from place to place to serve a private purpose, and are therefore proved by copies of them, which in the absence of the original, is the next best evidence.

A bill in Chancery has been admitted as slight evidence against the complainant; and an answer, is evidence against the defendant in equity himself, though not against others, and the whole may be read by the adverse party. Depositions in Chancery, may be evidence at law, but not against others, and regularly not if the witness be alive, except when taken in *perpetuam rei memorium*, &c. Matter in law ought not to be given in evidence upon a trial, but only of fact.

Of persons competent to give evidence. The King cannot be a witness under his sign manual, and a peer must be sworn to give evidence. A judge, or juror may give evidence, the one going off the bench, and the other stating his evidence in open court. Members of corporations cannot be heard in a cause for the corporation. In actions against churchwardens, &c. for money misspent, in indictments for repair of roads, and penal actions for the benefit of the parish, parishioners may be witnesses. Kinsmen are not to be objected to. Husband and wife are not received as witnesses for or against each other, and the bail cannot be a witness for his principal, on account of his direct interest in the event. One that has any benefit under a will, or deed, must release it before he can prove it as a witness, and by stat. 25 Geo. II. c. 6, any devise to a person who is witness to a will, or codicil, is void, and he shall be received as a witness. A bare trustee, it is said, may prove a deed made to himself. In actions for penalties on usury, the borrower, after he has paid the money, may be a witness to prove it, and in actions against the hundred, &c. the party is received as a witness in his own cause. Persons not of sound memory, attainted of præmunire or conspiracy, convicted of felony, perjury, or other infamous crimes, are incompetent to be received as witnesses, but these are restored to competency by the King's par-

don, and the witness shall not be asked any question to accuse himself, but it must be proved by producing the conviction; but upon conviction of perjury, under stat. 5 Eliz. c. 9, nothing but a reversal of judgment can restore a man to competency.

Wills of land must be attested and subscribed in the presence of the testator by three witnesses. In general, the courts are inclined to favour the receiving of evidence, and to consider objections as to interest, to go more to the credibility of the witness than to his competency.

A conviction of treason, of felony, and every species of infamous crime, as perjury, conspiracy, barratry, &c. prevent a man, when convicted of them, from being examined in a court of justice. When a man is convicted of any of the offences before mentioned, and judgment entered up, he is for ever after incompetent to give evidence, unless the stigma be removed, which, in case of a conviction of perjury, on the stat. of 5 Eliz. c. 9, can never be by any means short of a reversal of the judgment, for the statute has in this case made his incompetency part of his punishment; but if a man be convicted of perjury, or any other offence at the common law, and the King pardons him in particular, or grants a general pardon to all such convicts, this restores him to his credit, and the judgment no longer forms an objection to his testimony; but an actual pardon must be shewn under the great seal, the warrant for it under the King's sign manual not being sufficient to found this objection to the testimony of a witness, the party who intends to make it, should be prepared with a copy of the judgment regularly entered upon the verdict of conviction, for until such judgment be entered, the witness is not deprived of his legal privileges.

On the question, how far persons who have been defrauded of securities, or injured by a perjury or other crime, can be witnesses in prosecuting for those offences, the event of which might possibly exonerate them from the obligation they are charged to have entered into, or restore to them money which they have been obliged to pay; the general principle now established is this, the question in a criminal prosecution on personal act being the same with that in a civil cause, in which the witnesses are interested, goes generally to the credit, unless the judgment in the prosecution where they are witnesses, can be given in evidence in this cause wherein they are interested. But though this is the general rule, an exception to it seems to be established in the case of forgery; for many cases have been decided, that a person whose hand writing has been forged to an instrument, whereby if good he would be charged with a sum of money, or one who has paid money in consequence of such forgery, cannot be a witness on the indictment.

When a witness is not liable to any legal objection, he is first examined by the counsel for the party on whose behalf he comes to give evidence, which is called his examination in chief, who is not to put what are called leading questions, *viz.* to form them in such a way as would instruct the witnesses in the answers he is to give. He is then cross-examined by the other side, when leading questions are necessarily put; and then he is re-examined as to what he has been asked in his cross-examination.

The party examined must depose those facts only of which he has an immediate knowledge and recollection; he may refresh his memory with notes taken by himself at the time, and if he can then speak positively as to his recollection, it is sufficient; but if he have no recollection further than finding the entry in his book, the book itself must be produced. Deeds, receipts, and writings requiring stamps, must be stamped before they can be received in evidence.

Parole evidence shall not be admitted to annul or substantially vary a written instrument, nor to explain the meaning of a testator in a will, though where there are two persons of the same name; and it is doubtful which is the devisee from an imperfect description, it must be proved by witnesses which is the devisee. By the statute of frauds several things must be evidenced by writing, which previously might be proved by parole only. See Frauds.

The general rules has been for the last century under the ablest judges, that no man shall be asked a question, the answer to which might subject him to criminal punishment or pecuniary penalty. It has been lately attempted by some judges to extend it further, to prevent any question being asked which may degrade a man's character, which it is feared will deprive the parties of all the substantial benefits of cross-examination. By stat. 47 Geo. III. made on the spur of a particular occasion, and to serve a party purpose on the trial of Lord Melville, a witness cannot object to

answer a question, which may by the answer render him liable to an action at the suit of another party.

EULER (Leonard), in biography, one of the most extraordinary and even prodigious mathematical geniuses that the world ever produced. He was a native of Basil, and was born April 15, 1707. The years of his infancy were passed at Richen, where his father was minister. He was afterwards sent to the university of Basil; and as his memory was prodigious, and his application regular, he performed his academical tasks with great rapidity; and all the time that he saved by this, was consecrated to the study of mathematics, which soon became his favourite science. The early progress he made in this study, added fresh ardour to his application, by which, too, he obtained a distinguished place in the attention and esteem of Professor John Bernoulli, who was then one of the chief mathematicians in Europe.

In 1723, M. Euler took his degree as master of arts, and delivered on that occasion a Latin discourse, in which he drew a comparison between the philosophy of Newton and the Cartesian system, which was received with the greatest applause. At his father's desire he next applied himself to the study of theology and the oriental languages; and though these studies were foreign to his predominant propensity, his success was considerable even in this line. However, with his father's consent, he afterwards returned to mathematics as his principal object. In continuing to avail himself of the councils and instructions of M. Bernoulli, he contracted an intimate friendship with his two sons, Nicholas and Daniel; and it was chiefly in consequence of these connections that he afterwards became the principal ornament of the philosophical world.

The project of erecting an academy at Petersburgh, which had been formed by Peter the Great, was executed by Catharine the First; and the two young Bernoullis being invited to Petersburgh in 1725, promised Euler, who was desirous of following them, that they would use their endeavours to procure for him an advantageous settlement in that city. In the meantime, by their advice, he made close application to the study of philosophy, to which he made happy applications of his mathematical knowledge, in a dissertation on the nature and propagation of sound, and an answer to a prize question concerning the masting of ships; to which the Academy of Sciences adjudged the *accessit*, or second rank, in the year 1727. From this latter discourse, and other circumstances, it appears, that Euler had very early embarked in the curious and useful study of naval architecture, which he afterwards enriched with so many valuable discoveries. The study of mathematics and philosophy, however, did not solely engage his attention, as he, in the mean time, attended the medical and botanical lectures of the professors at Basil.

Euler's merit would have given him an easy admission to honourable preferment, either in the magistracy or university of his native city, if both civil and academical honours had not been there distributed by lot. The lot being against him in a certain promotion, he left his country, set out for Petersburgh, and was made joint professor with his countrymen, Hermann and Daniel Bernoulli, in the university of that city.

At his first setting out in his new career, he enriched the academical collection with many memoirs, which excited a noble emulation between him and the Bernoullis'; an emulation that always continued, without either degenerating into a selfish jealousy, or producing the least alteration in their friendship. It was at this time that he carried to new degrees of perfection the integral calculus, invented the calculation by sines, reduced analytical operations to a greater simplicity, and thus was enabled to throw new light on all the parts of mathematical science.

In 1730, M. Euler was promoted to the professorship of natural philosophy; and in 1733 he succeeded his friend D. Bernoulli in the mathematical chair. In 1735, a problem was proposed by the Academy, which required expedition, and for the calculation of which some eminent mathematicians had demanded the space of some months. The problem was undertaken by Euler, who completed the calculation in three days, to the astonishment of the Academy; but the violent and laborious efforts it cost him threw him into a fever, which endangered his life, and deprived him of the use of his right eye, which afterwards brought on a total blindness.

The Academy of Sciences at Paris, which in 1738 had adjudged the prize to his memoir concerning the Nature and Properties of Fire, proposed for the year 1740, the important subject of the tides of the sea; a problem whose solution comprehended

the theory of the solar system, and required the most arduous calculations. Euler's solution of this question was adjudged a masterpiece of analysis and geometry; and it was more honourable for him to share the academical prize with such illustrious competitors as Colin Maclaurin and Daniel Bernoulli, than to have carried it away from rivals of less magnitude. Seldom, if ever, did such a brilliant competition adorn the annals of the Academy; and, perhaps, no subject proposed by that learned body was ever treated with such force of genius and accuracy of investigation, as that which here displayed the philosophical powers of this extraordinary triumvirate.

In the year 1741, M. Euler was invited to Berlin to direct and assist the Academy that was there rising into fame. On this occasion he enriched the last volume of the Miscellanies (*Melanges*) of Berlin with five memoirs, which form an eminent, perhaps the principal figure in that collection. These were followed, with amazing rapidity, by a great number of important researches, which are dispersed through the memoirs of the Prussian Academy; a volume of which has been regularly published every year since its establishment in 1744. The labours of Euler will appear more especially astonishing, when it is considered, that while he was enriching the Academy of Berlin with a profusion of memoirs on the deepest parts of mathematical science, containing always some new points of view, often sublime truths, and sometimes discoveries of great importance; he still continued his philosophical contributions to the Petersburgh Academy, whose memoirs display the surprising fecundity of his genius, and which granted him a pension in 1742.

It was with great difficulty that this extraordinary man, 1766, obtained permission from the King of Prussia to return to Petersburgh, where he wished to pass the remainder of his days. Soon after his return, which was graciously rewarded by the munificence of Catherine the Second, he was seized with a violent disorder, which ended in the total loss of his sight. A cataract formed in his left eye, which had been essentially damaged by the loss of the other eye, and a too close application to study, deprived him entirely of the use of that organ. It was in this distressing situation that he dictated to his servant, a tailor's apprentice, who was absolutely devoid of mathematical knowledge, his elements of algebra, which by their intrinsic merit in point of perspicuity and method, and the unhappy circumstances in which they were composed, have equally excited wonder and applause. This work, though purely elementary, plainly discovers the proofs of an inventive genius; and it is perhaps here alone that we meet with a complete theory of the analysis of Diophantus.

About this time M. Euler was honoured by the Academy of Sciences at Paris with the place of one of the foreign members of that learned body, after which the academical prize was adjudged to three of his memoirs, "concerning the inequalities in the motions of the planets." The two prize questions proposed by the same academy for 1770 and 1772 were designed to obtain from the labours of astronomers a more perfect theory of the moon. M. Euler assisted by his eldest son, was a competitor for these prizes, and obtained them both. In this last memoir, he reserved for farther consideration several inequalities of the moon's motion, which he would not determine in his first theory, on account of the complicated calculations in which the method he then employed had engaged him. He afterward revised his whole theory, with the assistance of his son and Messrs. Krafft and Lexell, and pursued his researches till he had constructed the new tables, which appeared together with the great work, 1772. Instead of confining himself, as before, to the fruitless integration of three differential equations of the second degree, which are furnished by mathematical principles, he reduced them to the three ordinates, which determine the place of the moon: he divided into classes all the inequalities of that planet, as far as they depend either on the elongation of the sun and moon, or upon the excentricity, or the parallax, or the inclination of the lunar orbit. All these means of investigation, employed with such art and dexterity as would only be expected from a genius of the first order, were attended with the greatest success; and it is impossible to observe without admiration, such immense calculations on the one hand, and on the other the ingenious methods employed by this great man to abridge them, and to facilitate their application to the real motion of the moon. But this admiration will become astonishment, when we consider at what period, and in what circumstances all this was effected. It was when our author was totally blind, and consequently obliged to arrange all his computations by

the sole powers of his memory, and of his genius: it was when he was embarrassed in his domestic affairs by a dreadful fire, that had consumed great part of his property, and forced him to quit a ruined house, every corner of which was known to him by habit, which in some measure supplied the want of sight. It was in these circumstances that Euler composed a work which alone was sufficient to render his name immortal.

Some time after this, the famous oculist Wenzell, by couching the cataract, restored our author to sight; but the joy produced by this operation was of short duration. Some instances of negligence on the part of his surgeons, and his own impatience to use an organ, whose cure was not completely finished, deprived him a second time, and for ever of his sight: a relapse which was also accompanied with tormenting pain. With the assistance of his sons, however, and of Messrs. Krafft and Lexell, he continued his labours: neither the infirmities of old age, nor the loss of his sight, could quell the ardour of his genius. He had engaged to furnish the academy of Petersburgh with as many memoirs as would be sufficient to complete its acts for twenty years after his death. In the space of seven years he transmitted to the academy above seventy memoirs, and above two hundred more, left behind him, were revised and completed by a friend. Such of these memoirs as were of ancient date were separated from the rest, and form a collection that was published in the year 1783, under the title of "Analytical Works."

The general knowledge of our author was more extensive than could well be expected in one who had pursued, with such unremitting ardour, mathematics and astronomy as his favourite studies. He had made a very considerable progress in medical, botanical, and chemical science. What was still more extraordinary, he was an excellent scholar, and possessed in a high degree what is generally called erudition. He had attentively read the most eminent writers of ancient Rome; the civil and literary history of all ages and of all nations was familiar to him; and foreigners, who were only acquainted with his works, were astonished to find in the conversation of a man, whose long life seemed solely occupied in mathematical and physical researches and discoveries, such an extensive acquaintance with the most interesting branches of literature. In this respect, no doubt, he was much indebted to a very uncommon memory, which seemed to retain every idea that was conveyed to it, either from reading or from meditation. He would repeat the Æneid of Virgil, from the beginning to the end, without hesitation, and indicate the first and last line of every page of the edition he used.

Several attacks of a vertigo, in the beginning of September, 1783, which did not prevent his computing the motions of the aerostatic globes, were however the forerunners of his mild passage out of this life. While he was amusing himself at tea with one of his grand children, he was struck with an apoplexy which terminated his illustrious career at seventy-six years of age.

M. Euler's constitution was uncommonly strong and vigorous. His health was good, and the evening of his long life was calm and serene, sweetened by the fame that follows genius, the public esteem and respect that are never with-held from exemplary virtue, and several domestic comforts which he was capable of feeling, and therefore deserved to enjoy.

The catalogue of his works has been printed in fifty pages, fourteen of which contain the manuscript works. The printed ones consist of works published separately, and works to be found in the memoirs of several academies, viz. in thirty-eight volumes of the Petersburgh acts, (from six to ten papers in each volume); in several volumes of the Paris acts; in twenty-six volumes of the Berlin acts, (about five papers to each volume); in the Acta Eruditorum, in two volumes; in the Miscellanea Taurinensia; in vol. ix. of the Society of Ulyssingue; in the Ephemerides of Berlin; in the Memoires de la Société Oeconomique, for 1766.

EVOLUTE, in the higher geometry, a curve, which, by being gradually opened, describes another curve. Such is the curve B C F; (Plate V. Miscel. fig. 7.) for if a thread, F C M, be wrapped about, or applied to, the said curve, and then unwound again, the point, M, thereof will describe another curve, A M M, called by M. Huygens, a curve described from evolution. The part of the thread, M C, is called the radius of the evolute, or of the osculatory circle described on the centre, C, with the radius, M C.

Hence, 1. When the point, B, falls in A, the radius of the evolute, M C, is equal to the arch, B C; but if not, to A B, and the

arch B C. 2. The radius of the evolute, C M, is perpendicular to the curve, A M. 3. Because the radius, M C, of the evolute continually touches it, it is evident, from its generation, that it may be described through innumerable points, if the tangents in the parts of the evolute are produced until they become equal to their corresponding arches. 4. The evolute of the common parabola, is a parabola of the second kind, whose parameter is $\frac{27}{16}$, of the common one. 5. The evolute of a cycloid is another cycloid equal and similar to it. 6. All the arches of evolute curves are rectifiable, if the radii of the evolute can be expressed geometrically.

EVOLUTION. See ALGEBRA.

EVOLUTION, in the art of war, the motion made by a body of troops, when they are obliged to change their form and disposition, in order to preserve a post, or occupy another, to attack an enemy with more advantage, or to be in a condition of defending themselves the better. It consists in doublings, counter-marches, conversions, &c. A battalion doubles the ranks, when attacked in front or rear, to prevent its being flanked, or surrounded; for then a battalion fights with a larger front. The files are doubled either to accommodate themselves to the necessity of a narrow ground, or to resist an enemy which attacks them in flank; but if the ground will allow it, conversion is much preferable, because, after conversion, the battalion is in its first form, and opposes the file leaders, which are generally the best men to the enemy; and likewise, because doubling the files in a new or not well disciplined regiment, they may happen to fall into disorder.

EVOLVULUS, in botany, a genus of the Pentandria Tetragynia class and order. Natural order of Campanaceæ. Convolvuli, Jussieu. Essential character: calyx five-leaved; corolla five-cleft, rotate; capsule three-celled; seeds solitary. There are seven species, all natives of the East or West Indies.

EUONYMUS, in botany, English *spindle-tree,* a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx five-petalled; capsule five-sided, five-celled, five-valved, coloured; seeds calyptred, or veiled. There are eight species. These are trees or shrubs; the smaller branches or twigs four-cornered; the leaves opposite; peduncles axillary, solitary, opposite, one-flowered, sometimes many-flowered, disposed in umbels.

EUPAREA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx five-leaved; corolla five or twelve petalled; berry superior, one-celled; seeds very many, adhering to a free receptacle. There is only one species, *viz.* E. amoena, a native of New Holland and Terra del Fuego.

EUPATORIUM, in botany, English *hemp agrimony,* a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, oblong; style cloven half-way, long; down plumose; receptacle naked. There are forty-nine species. These are mostly tall growing perennial herbaceous plants; the greater part are natives of North America, many however from South America and the West Indies; several are found wild in the East Indies, and one only in Europe.

EUPHEMISM, in rhetoric, a figure which expresses things in themselves disagreeable and shocking, in terms implying the contrary quality: thus, the Pontus, or Black Sea, having the epithet αξενος, *i. e.* inhospitable, given it, by reason of the savage cruelty of those who inhabited the neighbouring countries, this name, by euphemism, was changed into that of Euxinus. In which signification nobody will deny its being a species of irony: but every euphemism is not irony, for we sometimes use improper and soft terms in the same sense with the proper and harsh.

EUPHONY, in grammar, an easiness, smoothness, and elegance in pronunciation. Euphony is properly a figure, whereby we suppress a letter that is too harsh, and convert it into a smoother, contrary to the ordinary rules: of this there are abundance of examples, in all languages.

EUPHORBIA, in botany, English *euphorbium, spurge,* a genus of the Dodecandria Trigynia class and order. Natural order of Tricoceæ. Euphorbiæ, Jussieu. Essential character: corolla four or five petalled, placed on the calyx; calyx one-leafed, bellying; capsule tricoceous. There are ninety-eight species. These are milky plants, mostly herbaceous, a few shrubby, upright for the most part, very few of them creeping; some are leafless; stems angular or tubercled, or more frequently cylindric or columnar; unarmed, or in the angular

sorts resembling the upright cactuses; armed with prickles, which are either solitary or in pairs, placed in a single row on the top of the ridges.

EUPHRASIA, in botany, English *eye-bright*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx four-cleft, cylindric; capsule two-celled, ovate, oblong; lower anthers have a little thorn at the base of one of the lobes. There are nine species.

EURYA, in botany, a genus of the Dodecandria Monogynia class and order. Essential character: calyx five-leaved, calycled; corolla five-petalled; stamina thirteen; capsule five-celled. There is but one species, *viz.* E. japonica, a native of Japan.

EURYANDRA, in botany, a genus of the Polyandria Trigynia class and order. Natural order of Coadunatæ. Magnoliæ, Jussieu. Essential character: calyx five-leaved; corolla three-petalled; filament much dilated at the tip, with twin disjoined anthers; follicles three. There is only one species, *viz.* E. scandens, a native of New Caledonia.

EUSTACHIAN *tube*, in anatomy, begins from the interior extremity of the tympanum, and runs forward and inwards in a bony canal, which terminates with a portion of the temporal bone. See ANATOMY.

EUSTEPHIA, in botany, a genus of the Hexandria Monogynia class and order. Corolla superior, tubular, cylindrical, bifid; nectary six cavities in the tube of the corolla; filaments tricuspidate, distinct. There is but a single species, *viz.* the coccinea.

EUSTYLE, in architecture, a sort of building in which the pillars are placed at the most convenient distance one from another, the intercolumniations being just two diameters and a quarter of the column, except those in the middle of the face, before and behind, which are three diameters distant.

EWRY, in the British customs, an office in the king's household, which has the care of the table linen, of laying the cloth, and serving up water, in silver ewers, after dinner.

EXAGGERATION, in rhetoric, a kind of hyperbole, whereby things are augmented or amplified, by saying more than the truth, either as to good or bad. There are two kinds of exaggeration, the one of things, the other of words. The first is produced, 1. By a multitude of definition. 2. By a multitude of adjuncts. 3. By a detail of causes and effects. 4. By an enumeration of consequences. 5. By comparisons. And, 6. By the contrast of epithets and rational inference.

Exaggeration by words is effected, 1. By using metaphors. 2. By hyperboles. 3. By synonymous terms. 4. By a collection of splendid and magnificent expressions. 5. By periphrasis. 6. By repetition. And lastly, by confirmation with an oath; as for example, "Parietes, medius fidius, gratias tibi agere gestiunt."

EXACUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rotaceæ. Gentianæ, Jussieu. Essential character: calyx four-leaved; corolla salver-shaped, with an inflated tube; capsule two-furrowed, two-celled, many-seeded, bursting at the top. There are ten species.

EXANTHEMA, among physicians, denotes any kind of efflorescence or eruption, as the measles, purple spots in the plague, or malignant fevers, &c.

According to Dr. Cullen it is an order in the class pyrexiæ, and includes all contagious diseases, beginning with fever, and followed by an eruption on the skin.

EXCELLENCY, a title anciently given to kings and emperors, but now to embassadors, and other persons, who are not qualified for that of highness, and yet are to be elevated above the other inferior dignities. In England and France the title is now peculiar to embassadors, but very common in Germany and Italy. Those it was first appropriated to, were the princes of the blood of the several royal houses; but they quitted it for that of highness, upon several great lords assuming excellency.

EXCENTRIC, in geometry, a term applied to circles and spheres which have not the same centre, and consequently are not parallel; in opposition to concentric, where they are parallel, having one common centre.

EXCENTRIC *circle*, in the Ptolemaic system, the very orbit of the planet itself, which it was supposed to describe about the earth.

EXCENTRIC *circle*, in the new astronomy, a circle described from the centre of the orbit of the planet, with half the axis as a radius.

EXCENTRIC *place of a planet*, is the very point of the orbit, where the circle of incli-

nation coming from the place of a planet in its orbit, falls thereon with right angles.

EXCENTRICITY, in astronomy, is the distance of the centre of the orbit of a planet from the centre of the sun, that is, the distance between the centre of the ellipsis and the focus. See ASTRONOMY *table.*

EXCEPTION *to evidence*, at common law, is the same as a bill of exceptions, which is a formal exception made in writing, to be signed by the judge, when any evidence is improperly refused or received, and is a record of such matter, which the judge is afterwards called upon to acknowledge in court, and then being made part of the record, it is argued in the same manner as any other point of error appearing upon the record. This proceeding is founded on the Stat. of Westminster, 2.

EXCEPTION, in law, is a clause whereby the party contracting, excepts, or takes a particular thing out of a general thing granted or conveyed, and it must be something which is not inseparable from it. It must not be the whole thing granted, but part thereof only, and must be conformable, and not repugnant, to the grant, for then the exception is void. It must also be described with certainty.

EXCHANGE, in political economy. The reciprocal payments of merchants are made in bills of exchange, the amount of which is expressed in the money of the country upon which they are drawn. In calculating the par of exchange, the coin of different countries is supposed to contain that quantity of gold or silver, of a determinate purity, which, agreeably to the regulations of their respective mints, it ought to contain. Thus an English guinea is supposed to contain $\frac{2}{89}$*lb.* troy of gold; and a shilling $\frac{1}{62}$*lb.* of silver, each of a certain degree of fineness.

When a bill of exchange upon Lisbon can be procured in London for the same weight of gold or silver which the sum of Portuguese money for which it is drawn is supposed to contain, exchange between London and Lisbon is said to be at par; when it can be procured for less, exchange is said to be below par, or in favour of London; when more must be given, exchange is said to be above par, or against London.

The value of all the bills of exchange which the merchants of London can draw upon the merchants of any other place, must in general be regulated by the value of the consignments which they have made to that place, and consequently the course of exchange affords an indication of the state of the trade between different countries. When bills upon Lisbon, for instance, are scarce in London, and exchange consequently above par, it is a sign that London owes more to Lisbon, than Lisbon to London; and the reverse is a sign of the contrary.

But there are other circumstances by which the course of exchange is very materially affected. Should the circulating coin of any country, *v. g.* be considerably debased, and its real value, the quantity of gold or silver which it really contains be much less than its nominal value, exchange may appear to be against a country, while actually it is in favour of it. Before the reformation of our silver coinage in the reign of William III. we are informed by Dr. Smith, the exchange between England and Holland computed by the standard of their respective mints, was 25 per cent. against England; but the current coin of England was at that time rather more than 25 per cent. below its standard value, and consequently exchange was really in favour of England. The issue of assignats during the revolution, depreciated the currency of France in a greater degree than was ever known in any other instance, and accordingly the exchange between London and Paris became between 60 and 70 per cent. against the latter place.

An unfavourable state of the exchange with any country furnishes a motive for exporting commodities to it. The merchant under these circumstances can afford to sell his commodities as much cheaper as the premium which he is obliged to pay for a bill of exchange amounts to. Hence the course of exchange always tends to an equilibrium. Indeed it can never really exceed the expense of sending gold or silver bullion to the place upon which the bill is drawn; since this is the money of the commercial world, and will every where be accepted in payment. Its apparent rise above this expense is to be ascribed to a depreciation of the currency or some similar cause. We shall now enter more into the practical part of exchange.

In treating this subject, we shall first give an idea of the nature of exchanges; in the second place we propose explaining the peculiar terms in use among merchants relative to bills; and, thirdly, we shall give examples of exchange with the principal

countries in commercial intercourse with Great Britain.

In transactions between a buyer and seller, both residing in the same place, it is obvious that the mode of payment is extremely simple. It takes place either in cash or by bill, and is attended with no intricacy of computation. Transactions between two towns in the same country are almost equally easy. Payment in cash is out of the question, but the seller either draws on the buyer a bill payable at the residence of the buyer, or if this residence is not a town of extensive trade, the buyer domiciles his acceptance at a place of this description; that is, he makes it payable there. The simplicity of this process arises from the money being of the same denomination in both places, and nearly of the same value. But in dealing with foreign countries, the calculation becomes less simple from the difference of denomination; and although this causes no real difference in the value of money, yet obstacles exist to the conveyance of specie, which almost always prevent money from being of equal value in two different countries at the same time.

Among merchants resident in different countries, bills serve nearly the same purpose as cash to the inhabitants of the same town. They are the current coin, by which the buyer in one country repays the seller in another; they pass like money from hand to hand; and this facility of circulation would always make money of nearly equal value in two countries, whose exchange of merchandize should be nearly equal. But it seldom happens that the exchange of merchandize is equal; there is almost always a balance on one side or the other; this balance must be paid in money; and money is consequently of greatest value on the spot where payment must take place. Hence the fluctuations of exchange. These fluctuations are greater or less according to the amount of the balance to be paid, and according to the expense and difficulty of conveying specie. By the expense of conveying specie is meant the carriage and insurance; by the difficulty, is meant the hazard of evading those prohibitory regulations, which in most countries impede its exportation. So powerful is the operation of these causes, that the exchange is often high, even between neighbouring countries; for instance, during 1793, the trade between Holland and England was completely open, insurance was low, and the voyage is known to be short, yet money was worth 10 or 12 per cent. more in England than in Holland; that is, a bill on London cost on the exchange of Amsterdam between 10 and 12 per cent. more than the intrinsic value of the money. This continued until the spring of 1794, when the King of Prussia having promised to act with vigour against the French, on condition of receiving a large subsidy, the remittance of a part of that subsidy through Amsterdam caused an immediate fall in the rate of exchange between England and Holland. At other periods of the war, it has been thought advisable that government should export specie rather than turn the course of exchange against us by the formidable operation of remitting a subsidy in bills.

II. Having explained the origin of fluctuations in exchange, we shall next advert to the peculiar terms, used in bill transactions.

Usance. This term, derived like many of our mercantile phrases from the Italian, (usanzia) means the customary period at which bills used to be drawn from one particular country on another. This period between Holland and England was a month. "At two usance pay to order of, &c." in such a bill means, "at two months after date pay to order, &c." Between England and Hamburgh, and between England and France, usance is also a month. Between England and Portugal or Spain, it is two months; and between England and Italy it is three months. Its length evidently increases with the distance of two countries from each other, and was regulated by the time formerly required for the conveyance of bills. In the American and West India trades, the phrase is not known, and the common term of a bill is sixty or ninety days after sight.

The word usance continues to be employed only from conformity to ancient custom; for it has no signification which would not be equally well expressed by the more generally intelligible phrase of months or days.

Days of grace. It has been judged fit by the legislatures of different countries, to consider the acceptance of a bill of exchange as an engagement decidedly obligatory on the acceptor. If he fail in paying it, he not only loses his credit, but the holder of the bill may, in most countries, arrest either his person or his property. The policy of these enactments is to give free currency to bills of exchange, by satisfying the

buyer or holder of a good bill that the obligation in his hands is almost as effectual as money. Having given so much power to the holder, it was thought advisable to extend some indulgence also to the acceptor. Accordingly days of grace were allowed him, that is, it was ordered that the holder should take no measures, and not even protest an acceptance until the expiration of certain days after the bill became due. In London three days of grace are allowed; in Amsterdam, six; in Hamburgh, twelve; in Dantzic, ten; in Copenhagen, eight; in Berlin, three; and a different term in almost every distinct mercantile city.

The practice of giving days of grace is, now at least, of no real use; for every acceptor, knowing that he may avail himself of them, does not fail to do it, and it would be considered quite ridiculous in the holder of a bill to send it for payment before the end of the three days. So that when a bill is drawn at sixty days sight or date, the only effect of the days of grace is to make sixty, sixty-three.

Protest. This is the notarial act which denotes that an irregularity has taken place in regard to the bill, either that it is not accepted, or that it is not paid. In some branches of trade it is customary, in cases of non-acceptance, not to extend, but only to note a protest. Noting a protest is said when a notary only records the irregularity; to extend a protest, implies that he has written out on a stamp a formal statement of that irregularity.

In a case of non-acceptance, the protest gives the holder of course no power over the person on whom the bill is drawn, but it enables him in some countries to demand security from the person of whom he received it; in other countries, the holder can do little or nothing with a protest for non-acceptance; and in these cases he generally contents himself with noting a bill when acceptance is refused. In our West India trade, for example, it is much more customary merely to note bills for non-acceptance, than to extend the protest; for it is only in particular colonies (St. Vincent, for instance) that the holder can take prompt measures to oblige the drawer to find security to him for the amount of the bill: But on refusal of payment, a protest should always be extended; otherwise the holder would, by this omission, relieve every indorser on the bill from responsibility, and have no recourse, except on the drawer. If an accepted bill is refused payment, it is a proof that the acceptor is insolvent. The holder may either proceed against the acceptor, or he may send back the bill to the last indorser, or if there be no indorser, to the drawer. The drawer, or last indorser, as the case may be, is pledged to refund the amount immediately to the holder. This mode being generally the speediest means of reimbursement, the holder always prefers it when he can obtain payment by it; but in case of the insolvency of both drawer and acceptor, the holder retains the bill, and gets what he can from the estates of both.

When the Bank of England finds that a merchant has suspended payment, their rule is to examine all the bills drawn upon him, which have been discounted by different persons at the Bank, and to send notice to these persons that the Bank expect the bills will be taken up and the money refunded. It is disreputable not to comply as early as possible with this intimation.

In our West Indian colonies, the proceedings against insolvent persons are much more tedious than here. These colonies have hitherto been considered in a state of progressive advancement; the industry of the colonist, and the use he makes of borrowed capital, are deemed the means of this improvement; and it has been judged politic to protect him to a certain extent against his creditor. A man cannot in our West India colonies, as at home, be made a bankrupt; his property can be taken possession of by his creditors only after a process of considerable duration; and in the payment of the debts of an estate, a preference is regularly given to colonial claims. These laws proceed upon the belief that the profits on capital are rapid in these colonies, and that the best way for the public is to give such time to the debtor as may enable him to reap some gain before he is forced to refund the principal; or rather, the money when borrowed is sunk in land and stock, which can be productive only in time to the tenant, and his creditor, like himself, must be satisfied with a gradual return. A new æra, however, is now created in the history of the West Indies: the depreciation of their produce proves, that its culture is now sufficiently extended; and the abolition of the slave-trade will take away the means of further speculation. These colonies should therefore be now considered in nearly the same state as the mother country, as far as regards mercantile affairs. At present such is the uncer-

tainty of getting value for a bill of exchange drawn on an inhabitant of the West Indies, that scarcely any such bills can be said to exist: their payments are accordingly made by bills on Britain, and the exchange is generally high, being from 5 to 15 per cent. or more, in favour of the mother country.

The United States of America are in a similar state of cultivation; the bankrupt laws are introduced into a part only of these provinces, and the scope of American policy is to afford security to the creditor, without enabling him to compel payment from his debtor, until after a process of great length.

Accommodation Bills. By this term are understood bills drawn not on occasion of a real transaction, but for the purpose of affording a temporary supply of money, or accommodation to the parties. Such bills obtain currency for several reasons. It is often difficult to distinguish a real from a fictitious bill: even when a bill is considered fictitious, it will still obtain currency, as the holder of it has the double security of the drawer and acceptor. It is as valid as a real bill, the law considering only whether the holder has given value for it, and protecting him in the recovery of that value: the shortness of the term also (seldom exceeding two months, and never almost exceeding three) naturally induces persons to think, that although the drawer and acceptor be of doubtful credit, they will not fail quite so soon; and, in the worst event, the holder has the prospect of a double chance of recovery from the estates of both parties.

These circumstances have given a surprizing currency in this country to accommodation bills. They are as adverse, however, to commercial prosperity as real bills are favourable to it. If the negociator of accommodation bills compute the expence of exchange, stamps, the country bank charge, and the loss of his own time, he will find that he pays nearer seven than five per cent. interest for the loan. In nine instances out of ten these bills fail of producing their wished for effect, namely, a relief from difficulties; and the unfortunate merchant, after wasting several of his best years in toil and agitation, is obliged to lay his affairs before his creditors in a much worse state than if he had decided on such a measure in the beginning of his embarrassments. These embarrassments almost always proceed from going beyond his depth. The ambition which leads a man to advance his circumstances, and the hope which makes him strive by great exertion to avoid a mortifying exposure, are highly commendable in themselves, but the public in this country has much reason to complain of the excess to which they are carried. Accordingly the Bank of England directly discountenances all accommodation paper; they even withold discounts from all brokers and middlemen, and endeavour, wherever they can trace the transaction, to confine their discounts to the direct acceptance of the buyer to the seller.

In the United States of America the banks avowedly sanction the practice of accommodation, and discount bills which they know to be fictitious. They are careful indeed to have at least one good name on these bills, so that they themselves are seldom losers; but the practice creates a serious evil to the country. These bills, when due, must be paid by others of the same stamp; the vortex is endless, and a war with England would produce a general failure among the exporters of American produce.

Exchanges, *arbitration of*, are calculations made to find through what intermediate place it will be most advantageous to draw or remit.

The drawee is the person in whose favour a bill is drawn; the payee means the last holder, or the person to whom payment ought to be made.

III. We shall now give a few examples of the mode of computing exchange with other countries.

To begin with *Amsterdam*. The par of exchange between England and Holland is 11 florins, or guilders, for a pound sterling. The denomination of money most usual in Holland is that of guilders, stivers, and pennings.

16 pennings make..........1 stiver
20 stivers......................1 guilder.

But by a useless adherence to antiquated rules, another denomination of money is occasionally employed; a practice always perplexing at first, and aukward in some measure even to those who are accustomed to it. This denomination is called Flemish, and is as follows:

12 grotes......make......1 schilling
20 schillings ....1 pound Flemish.

Foreign exchanges are stated in this money, and the par with London is *36s.* 8. or in other words eleven guilders (*f* 11.)

Ex. Reduce 240*l.* sterling into Dutch money, at the exchange of 37. 4*fls.* per pound sterling.

As £1 : 37. 4*fls.* ::	£240
multiply by	37 4
	1680
	720
for four grotes	80
	8960*sch.*
equal to	£ 448 *Fl.*

which again is equal to *f* 2668; there being 6 guilders in a pound Flemish.

The difference between the bank and current money in Holland is called the agio. Exchange is always quoted in current money; but as bills are paid in bank money, a further operation (too easy to want explanation) is necessary to give the amount in bank money.

Prove the preceding operation by reducing *f* 2668 into sterling, at the exchange of 37. 4*fls.* per pound sterling. Before dividing the former sum by the latter, which is obviously the mode to solve the question, both must be reduced to a common denomination. Thus,

f 2668 reduced to stivers is 53760
37. 4*fls.*.......ditto....... 224

And 53760, divided by 224, gives a quotient of 240*l.* sterling.

Hamburgh. Here, as in Holland, there are two denominations of money; one is the Flemish, which we have already stated; the other is that of marcs, shillings, and pennings lubs.

12 pennings = 1 shilling lubs
16 shillings = 1 marc.

A shilling lubs is equal to two grotes Flemish.

Reduce 150*l.* sterling into Hamburgh bank money, at the exchange of 35. 4*fls.* (Hamburgh bank money) per pound sterling.

As £1 sterling : 35. 4*fls.* ::	£150
multiply by	35 4
	750
	450
for four grotes	50
	5300
equal to	£ 265 *Fl.*

To reduce this to marcs, multiply by $7\frac{1}{2}$, that being the number of marcs in a pound Flemish; the product is 1987 marcs, 8 shillings.

Reverse the operation, by reducing 1987 marcs, 8 shillings, to sterling money, at the rate of 35. 4*fls.* per pound sterling. Reducing both sums to the same denomination, namely grotes,

35. 4*fls.* are................ 424 grotes
1987 marcs 8 shillings lubs. 63,600
And 63,600 divided by 424 yields 150*l.*

Ireland. The intrinsic difference between British and Irish money is 8*l.* 6*s.* 8*d.* per cent., 12*l.* British making 13*l.* Irish. The exchange, however, is almost always considerably higher than this.

In reducing a sum in sterling into Irish the operation is easy.

Reduce 350*l.* sterling into Irish money, at a premium of 14 per cent. The rule is, take the premium on the sterling amount, and adding the two together, the product is the amount in Irish money.

Thus, to.........	£350
add 14 per cent. on 350*l.* namely.	49
Amount in Irish.......	£399

Reduce next 399*l.* Irish into sterling, at a discount of 14 per cent.

It will not do to take the difference on the 399*l.* and deduct it, expecting that the remainder will be the sterling sum. This would be taking discount upon discount. We must go through the following operation:

As £114 : £100 :: £399
Multiply by 100 £

Divide by 114)39900(350 quotient.
342
570
570
00

The above-mentioned rules apply in all cases where the rate of exchange is stated at so much per cent.

United States. The denomination of money in America is the most simple of any: their table is briefly,

1 dollar = 100 cents.

A dollar is computed worth 4*s.* 6*d.* sterling, at par, therefore 40 dollars are equal to 9*l.* sterling.

Reduce 175*l.* sterling into dollars and cents, at par. Multiply by 40, and divide by 9; the quotient is the answer.

```
£175
  40  dol. cts.
9)7000(777 77
  63
  70, &c.
```

When the exchange is either above or below par, the rule is still the same: the amount in dollars and cents is first found at par, and the premium or discount is deducted from, or added to that amount.

It is still common to transact business and keep accounts in current money in most of the American provinces, although these currencies are not recognized by law. In New England and Virginia a dollar is worth 6 shillings currency, and 100*l.* sterling is therefore equal to 133½*l.* currency.

In Delaware, Maryland, New Jersey, and Pennsylvania, a dollar is worth 7*s.* 6*d.* currency, and 100*l.* is equal to 166*l.* 2*s.* 3*d.* currency.

Finally, in New York and North Carolina a dollar is worth 8*s.* currency; therefore 100*l.* sterling is equal to 177*l.* 7*s.* 9*d.* currency.

The shortest modes of reducing these currencies into sterling money are the following.

When the dollar is worth 6*s.* currency, multiply the sum in current money by 3, and divide by 4; the quotient is sterling. When the dollar is worth 7*s.* 6*d.* currency, multiply by 3 and divide by 5; and when it is worth 8*s.* currency, multiply by 9 and divide by 16.

West Indies. The difference between sterling money and Jamaica currency is 40 per cent.; 140*l.* currency being the par to 100*l.* sterling. To reduce Jamaica currency into sterling, multiply the currency by 5 and divide by 7.

In most of the Windward and Leeward islands 175*l.* currency is the par to 100*l.* sterling. The rule in this case is to multiply the current sum by 4, and divide it by 7.

Exclusive of these permanent differences between sterling and currency, there is also an exchange between the West Indies and the mother country, varying, as already mentioned, from 5 to 15 per cent. It is frequent in the Windward Islands to consider in small payments one shilling sterling as equal to two shillings currency, which supposes an exchange in favour of Britain of 12½ per cent.

It very often happens that bill payments take place by *indirect* channels. A Bristol merchant purchasing grain in Holland makes the Dutch merchant reimburse himself by drawing on a mercantile house in London or Amsterdam, or if the Dutch merchant draw on the Bristol merchant himself, he makes it a condition that the bill shall be accepted payable in London. The object of this is to give an easy currency in negotiation to the bill. The Dutch merchant sells his bill on the Amsterdam exchange; where, for one man who wishes to buy a bill on Bristol, he will find twenty who wish to purchase on London. Hence the tendency of all exchange transactions to certain central points. That point is always the principal trading city in the country. Throughout Great Britain a bill on London is preferred to a bill on any other place; and what London is to this country, Amsterdam, in its better days, was to Europe.

Every country town is said to have its par of exchange on London. By this is meant the term or number of days at which the country bank will give a bill on London in exchange for cash. This term is greater or less, according to the distance from London. In Bristol it is twenty-five days, in Liverpool thirty, in Glasgow forty-five, and in the more remote parts of Scotland fifty days.

It is important to know, that a very small matter will amount to an acceptance. If the acceptor write his name on the bill, he must pay it; if he even prefix to his signature a notice that he will *not* pay it, this very writing binds him to pay it; in short, if the person on whom a bill is drawn, means to decline acceptance, he is not safe in putting the least mark on it, except the number denoting its entry in his bill book.

Table of the Course of Exchange for September 23, 1807.

Amsterdam		35 5 2 U.
Ditto sight		34 9
Rotterdam		11 12 U.
Hamburgh		34 22½ U.
Altona		34 32½ U.
Paris	1 d.	24 6
Ditto		24 10 2 U.

Bourdeaux.............	34 10
Madrid.................	$39\frac{1}{2}$ Eff.
Cadiz....................	$38\frac{3}{4}$ Eff.
Bilboa..................	$38\frac{3}{4}$ Eff.
Palermo................	92 a per oz.
Leghorn................	5
Genoa...................	$45\frac{1}{2}$
Venice..	52 in ef.
Naples..................	42
Lisbon..................	64
Oporto.................	$63\frac{3}{4}$
Dublin.................	$10\frac{3}{4}$ per cent.
Cork.....................	$11\frac{1}{2}$
Agio, B. Hol.........	$5\frac{1}{2}$ per cent.

An explanation of this table, which is taken from the public papers, may be necessary to those of our readers who are not conversant with mercantile topics. Let us suppose a merchant desirous to sell on the Royal Exchange, London, a bill for 1000*l.* sterling on Amsterdam. The question between him and the buyer is, " How many schillings and grotes per pound sterling are to be paid at Amsterdam?" This is answered by the table, which states, that if the bill be made payable at sight, the rate is only 34 schillings and 9 grotes per pound sterling; but if it be payable at 2 usance, that is, at two months after date, the rate will be 35 schillings and 5 grotes. This difference is in lieu of the interest of the money for the interval.

In the case of Ireland, the rate of exchange is quoted at so much per cent. At the date of the prefixed table, there would have been given on the Exchange of London for 100*l.* sterling a bill on Dublin for 110*l.* 15*s.* Irish; or one on Cork, for 111*l.* 10*s.* Irish.

By the agio of the Bank of Holland is meant the difference between cash and bank money. Formerly cash money bore a premium of $1\frac{1}{2}$, 2, or $2\frac{1}{2}$ per cent.; but since Holland fell under the French dominion, it has been at a discount.

By 1 *d.* annexed to Paris, is to be understood one day's sight: 24 : 6 means 24 livres 6 sous per £. sterling. The Madrid exchange is $39\frac{1}{2}$*d.* sterling per dollar of 8 reals plate, or 272 marvedis. The Venetian 52*d.* sterling per ducat banco. In the Sicilian exchange the term *oz.*, or *onzia*, signifies an ounce, meaning an ounce of silver.

Exchange signifies also a place in most considerable trading cities, wherein the merchants, negociants, agents, bankers, brokers, interpreters, and other persons concerned in commerce, meet on certain days, and at certain times thereof, to confer and treat together of matters relating to exchanges, remittances, payments, adventures, assurances, freightments, and other mercantile negociations, both by sea and land.

These assemblies are, in some countries, held with so much exactness, that the absence of a merchant, &c. makes him suspected of drawing to a failure of bankruptcy, as not being able to stand the change.

The most considerable exchanges in Europe, are those of Amsterdam, and that of London, called the Royal Exchange. See Royal Exchange.

Exchange, in law, is a mutual grant of equal interests, the one in consideration of the other; and upon such a conveyance, no livery of seisin, even of freehold, is necessary to perfect it; for each party stands in the place of the other, and occupies his right, and each of them hath already had corporal possession of his own land. But entry must be made on both sides; for if either party die before the entry, exchange is void for want of sufficient notoriety.

Both the estates exchanged should be equal. But not equal value, but only in the kind and manner of the estate.

Exchange-*re*, is when the holder of a bill finds it not paid by the acceptor, then it becomes necessary to draw other bills upon the parties, which create exchange, and the exchange paid upon that transaction are, by the usage of merchants, chargeable upon the preceding parties to the bill, by way of re-exchange.

EXCHEQUER, from the French *eschequier*, i. e. *abacus tabula lusoria*, is a court of law and equity, established by William the Conqueror, as a part of the *aula regis*, though regulated and reduced to its present state by Edw. I. and intended principally to order the revenue of the crown, and to recover the King's debts and duties. The court consists of two divisions, *viz.* the receipt of the exchequer, which manages the royal revenues; and the judicial, which is again subdivided into a court of equity, and a court of common law. The court of equity is held in the Exchequer, before the Lord Treasurer, the Chancellor of the Exchequer, the Chief Baron, and three puisne

Barons.' The primary and original business of this court was to call the King's debtors' to account, by bill filed by the Attorney General, and to recover any lands, tenements, or hereditaments, goods, chattels, or other profits or benefits, belonging to the crown; but now, by a fiction of law, suggesting that the party is a debtor of the King, and is less able to pay his debt, unless he has the aid of the court to recover of his own debtor; any person may be admitted to sue here. An appeal from the equity side of this court, lies immediately to the House of Peers; but from the common law side, pursuant to 31 Edw. III. c. 12, a writ of error must first be brought into the court of exchequer chamber, whence appeal lies to the House of Lords. The exchequer as a court of law is the last of the courts.

In this court suits are generally brought for tythes, although the court of Chancery also exercises considerable jurisdiction in that respect. The Exchequer is also divided into the court for judicial business; and the other, the receipt of the Exchequer, in which the accounts of the revenue are kept, and the money is received: in this branch of the Exchequer there are several offices; such as two chamberlains, the controller of the pipe, the clerk of the estreats, the foreign opposer, the auditors, the four tellers, the clerk of the pells, clerk of the nichils, &c. By stat. 23 Geo. III. c. 82, the offices of the two chamberlains, tally-cutter, usher, and second clerks to each teller, shall, after the death of the present officers, be abolished; and instead of tallies, indented cheque receipts are to be used: also after the death of the auditor, clerk of the pells, four tellers, and two chamberlains, their fees shall be abolished, and their salaries be fixed.

Exchequer *chamber*. This court has no original jurisdiction, but is merely a court of appeal, to correct the errors of other jurisdictions, and consists of the Lord Chancellor, the Lord Treasurer, with the Justices of the King's Bench and Common Pleas. In imitation of this, a second court of Exchequer chamber was erected by 27 Eliz. c. 8, consisting of the Justices of the Common Pleas, and the Barons of the Exchequer, before whom writs of error may be brought to reverse judgments in certain suits, commenced originally in the court of King's Bench. Into the Exchequer chamber are sometimes adjourned, from the other courts, such causes, as the judges, upon argument, find to be of great weight and difficulty, before any judgment is given upon them in the court.

Exchequer, *Chancellor* of, is in Great Britain, the officer to whom the arrangement of the financial concerns of the country is chiefly entrusted. He causes accounts to be annually laid before parliament of the produce of the taxes, with estimates of the several branches of public expenditure for the ensuing year; and if the amount of the estimated expenditure exceeds the probable produce of the revenue, he adjusts the extent and conditions of the loan with such persons as are willing to advance the same, and proposes to parliament the new taxes which become necessary for paying the interest on the money thus borrowed. On the foundation of the accounts, and estimates submitted to parliament, particular sums are voted for the several branches of the expenditure; and where the ways and means of raising the whole sum wanted have been determined, an act is passed appropriating the specific sums to the various articles forming the supplies which have been granted. In order to provide against any unforseen expences, it is usual to grant also a certain sum appropriated to any particular purpose, to be applied to any branch of the expenditure in which there may be occasion for it; this is called a vote of credit, and has increased in amount with the progress of the supplies; in the American war it was 1,000,000*l*. per annum, of late it has generally been 2,500,000*l*. Soon after the commencement of each session, an account is laid before the House of Commons, shewing how the money given for the service of the preceding year has been disposed of, and what part thereof remains unpaid. If the ways and means have fallen short of the sum they were expected to produce, the deficiency is made good as an article among the next year's supplies.

Exchequer bills, bills or tickets issued by the Exchequer, payable out of the produce of a particular tax, or generally out of the supplies granted for the year, and receivable in all payments to the exchequer. The first bills of this kind were issued in 1697, as a more convenient kind of security than the tallies and orders for repayment then in use, and were partly intended to supply the want of money during the recoinage then undertaken. With this view,

many of them were made out for small sums, as low as 10*l.* and 5*l.* each; and though they bore no interest when first issued, upon being re-issued after having been paid into the Exchequer upon any of the taxes, they carried interest at 5*d.* a day per cent, equal to 7*l.* 12*s.* 1*d.* per cent. per annum. These bills being regularly discharged, other sums were soon raised on similar securities, and their credit becoming established, they have ever since been used for anticipating the produce of particular taxes, and have almost constantly formed the principal article of that part of the public debt called the unfunded debt. Of late years the total amount of outstanding Exchequer bills (exclusive of those charged on specific branches of the revenue) has usually been about twelve millions. The interest payable on them has been at various rates according to the current rate of interest at the time they were issued; those at present (1808) in circulation bear interest at the rate of 3½*d.* a day per cent. They are frequently made out for 100*l.* each, but those issued of late years have been chiefly for 1000*l.* each, and they have sometimes been made for much larger sums: they are numbered arithmetically, and registered accordingly, for the purpose of paying them off in regular course, the time of which is notified by public advertisment.

The daily transactions between the Bank and the Exchequer are chiefly carried on by these bills, which are deposited by the Bank in the Exchequer to the amount of the sums received by them on account of government; the bank notes and cash thus received by the Bank being retained by them, as the detail part of the money concerns of government is all transacted at the Bank. The instalments on loans are paid into the receipt of the Exchequer in Exchequer bills, which are received again by the Bank as cash, either for the amount of dividends due, or in repayment of advances.

When these bills sell at a considerable discount, or any other circumstance indicates that the quantity of them in circulation is too great, the usual expedient is to fund a part of them, that is, to convert them into a permanent debt by offering the holders of them stock in lieu of their bills; this was done in October 1796, in November 1801, and again in March 1808. The total amount of Exchequer bills outstanding on the 5th of January 1807, including 3,000,000*l.* held by the Bank, pursuant to an agreement for the renewal of their charter, was 27,207,100*l.*

Exchequer, *black book of the*, a book containing a description of the court of England in 1175, and its officers, with their ranks, wages, privileges, perquisites, &c. also the revenues of the crown, both in money and cattle.

EXCISE *duties*, inland taxes on commodities of general consumption. This mode of taxation having been always found very productive, has been adopted by all the European governments, and by some of them has been extended even to the necessaries of life; but, in general, the articles subjected to it have been such as are not absolutely essential to subsistence. Salt appears to have been the object of an excise duty at a very early period; in later times oil, wine, tobacco, and various other consumable articles have been burthened with duties of this description.

Excise duties were first established in England in 1643, when the long parliament laid a tax on beer and ale in all the counties within their power; and the king's parliament, then sitting at Oxford, imposed the like taxes on all within their power, by which means these new duties called excise became general. It is supposed that the plan was originally adopted in consequence of its success in the neighbouring commonwealth of Holland. It was at first laid upon liquors only; and it was solemnly declared that, at the end of the war, all excises should be abolished; but the contest continuing longer than was expected, this obnoxious mode of levying money was extended to bread, meat, salt, and many other articles. The excise on bread and meat was afterwards repealed.

In the year 1660, two duties were imposed on English ale, amounting to 2*s.* 6*d.* per barrel of strong, and 6*d.* per barrel of small beer; a duty of 2*d.* per gallon was also imposed on home-made spirits. These duties were farmed till the year 1684, when they were put under the management of commissioners. For a considerable time they yielded a revenue that was gradually increasing, and which amounted, in the year ending Midsummer 1688, to 786,915*l.* 12*s.* 7*d.* Soon after the revolution several temporary duties were imposed on beer and ale; and in 1694, the established duties were 4*s.* 9*d.* per barrel on strong, and 1*s.* 3*d.* per barrel on small beer: the augmentation of the

revenue was not, however, proportionate to the increase of the duties, which was attributed by Dr. Davenant to improper management, but probably arose, in part at least, from the increased temptation to evade the duties.

Various additions to the original duties were made at subsequent periods, and the excise being extended to candles, soap, starch, hides, and other articles, it became one of the most productive branches of the public revenue; the gross produce, in the year 1732, being 2,964,617*l.* About this time Sir Robert Walpole, who was of opinion that taxes on consumable commodities, to which every citizen contributes in proportion to his consumption, and which being included in the price of the commodity are insensibly paid, constituted the most eligible mode of raising the revenue necessary for the public service; formed a project for the gradual abolition not only of the taxes on land, houses, and windows, but likewise the customs, by the substitution of productive excise duties. He was influenced in the formation of this scheme by a knowledge of the gross and shameless frauds then daily practised in the collection of the customs; and which, from the very nature of those frauds, and the extreme facility of committing them, he had no hope to remedy: he thought, therefore, that to convert the greater part of the customs into duties of excise, would be equally advantageous to government and to the fair trader; and that the excise laws might be so ameliorated that, notwithstanding the odium generally attached to them as oppressive and arbitrary, no just ground of complaint should remain. With a view, therefore, to the execution of this plan, he obtained a revival of the salt duties, which had been repealed some years before; but upon proposing, in the following year, to transfer the duties on wine and tobacco to the excise, so much clamour was raised against the measure that the minister, after some perseverance, thought it prudent to relinquish this favorite project. The defeat of this scheme was celebrated by general rejoicings, as a deliverance from the greatest political danger: had it succeeded, between four and five millions a year would have been raised under the excise system, in addition to the excise duties then subsisting: by the various duties which at different times have been since imposed, upwards of fifteen millions a year is now raised under the excise, in addition to the amount of this branch of the revenue at the above period.

The several commodities now subject to excise duties are ale and beer, cyder, perry, mead, British and foreign spirits, wine, vinegar, verjuice, malt, hops, salt, soap, starch, candles, coffee, tea, tobacco and snuff, bricks and tiles, glass, hides and skins, paper, printed goods, and wire. The various rates of duty which had been imposed at different times were consolidated in the year 1787, when other regulations were also adopted, by which the produce of the revenue was augmented, and the expense of collecting it materially reduced, as appears from the rate per cent. which the expenses of management amounted to in the following years:

Years.	Gross Receipt.	Rate per cent.		
	£.	£.	s.	d.
1789	8,418,611	5	10	0
1790	9,054,850	5	11	0
1791	9,808,908	5	0	4
1792	10,113,867	4	19	10
1793	9,412,487	5	5	7
1794	9,964,293	5	0	4
1795	10,866,170	4	13	11
1796	10,960,425	4	12	1

The additional duties which the progress of the public expenditure has rendered it necessary to impose, have greatly increased the produce of the excise, and rendered it the most important branch of the public revenue. The duties which it comprehends are divided into the permanent consolidated duties, the temporary war taxes, and the annual duties; the latter consist of the old annual malt duty, and of an additional malt duty, which with some duties on tobacco and snuff, and some custom duties, have, since the project for selling the land tax, been granted annually in lieu thereof.

Total gross produce of the Excise Duties in England, in the year ending the 5th of January, 1807.

	£.	s.	d.
Auctions	249,891	14	1¼
Beer and ale	2,971,351	15	7¼
Bricks and tiles	306,661	10	0¼
Candles	311,449	4	8
Cocoa-nuts and coffee	124,178	5	7½
Cyder and perry	19,772	5	1¾
Glass	424,786	3	9¾
Hides and skins	311,322	17	1
Hops	56,339	15	2½
Licences	301,083	17	11¼
Malt	1,388,130	8	8¼
Metheglin, or mead	161	8	9
Paper	359,158	5	5½
Printed goods	698,373	17	8
Salt	1,470,704	13	2¾
Soap	586,564	5	7½
Spirits, British	1,201,200	19	11
Ditto, foreign	1,772,866	14	5¾
Starch	60,025	14	0¼
Sweets	24,771	0	6¼
Tea	1,280,751	16	8½
Tobacco and snuff	196,188	10	10¼
Vinegar and verjuice	38,024	14	7½
Wine	1,149,313	8	7¼
Wire	13,388	9	11
WAR TAXES.			
Wine	210,292	7	3¼
Malt	2,713,172	10	8¾
Spirits, British and foreign	1,473,936	6	11¼
Sweets	4,483	12	3¼
Tea	1,313,664	13	7¼
Tobacco and snuff	162,342	18	10½
ANNUAL DUTIES.			
Old malt duty	676,810	12	0¼
Additional malt duty	1,115,491	1	9
Tobacco and snuff	428,140	4	9¼
Total	£ 23,414,796	6	7¼

The balance of cash at the commencement of the year being 27,790*l.* 3*s.* 3¾*d.* added to the above sum, makes the total to be accounted for 23,442,586*l.* 9*s.* 11*d.* This amount is subject to various deductions, consisting principally of the expenses of management, drawbacks of duty on goods exported, allowances and bounties on several commodities, annual payments to the officers of the late wine licence office and of the old salt duties, and pensions granted by patent out of the excise while it formed part of the hereditary revenue of the crown. The amount of these payments in the year ending the 5th of January, 1807, was as follows:

	£.	s.	d.
Charges of Management	569,341	0	$4\frac{1}{4}$
Taxes repaid to officers	30,513	15	$8\frac{3}{4}$
Exports	920,712	3	10
Allowances	69,242	5	$11\frac{1}{4}$
Bounties	20,304	19	$5\frac{1}{4}$
Overcharges, overpayments, repayments per treasury warrant, &c	29,701	15	$0\frac{3}{4}$
Payments to officers of late wine license office and salt duties	10,599	4	$5\frac{1}{4}$
Pensions to the Duke of Grafton and others	14,000	0	0
Payments into the Exchequer	21,739,067	12	10
Balance of cash remaining the 5th of January, 1807, carried to the next year's account	39,103	12	$3\frac{1}{2}$
Total £	23,442,586	9	11

The total gross produce of the excise duties in Scotland, in the above year, was 1,824,394*l.* 0*s.* $6\frac{1}{2}$*d.*; of which the sum of 1,445,000*l.* was paid into the exchequer during the year. The total gross produce of the excise duties in Ireland, for the same year, was 1,453,500*l.* 0*s.* 2*d.*

The excise duties of England are under the management of nine commissioners, with salaries of 1200*l.* per annum each; and they are sworn to take no fee or reward but from the king only. From these commissioners there lies an appeal to five others, called commissioners of appeals. The commissioners of excise in Scotland are five in number, and have salaries of 600*l.* per annum each. The number of officers employed in collecting this branch of the revenue is very great. Besides the commissioners and their subordinate officers, as secretary, comptrollers, auditor, accomptants, registers, inspectors, and a great number of clerks in the different departments; there are 24 country examiners, 284 supervisors, 2750 gaugers, or excisemen, &c. Previous to the appointment of any person to the office of gauger, he must procure a certificate of his age, which must be between 21 and 30; he must understand the four first rules of arithmetic; be of the communion of the Church of England; and, if married, not have more than two children; he must nominate two persons to be his securities: and the certificate containing these particulars, and written by himself, must be signed by the supervisor of the district where he lives, and accompanied with an affidavit that he has used no bribes for obtaining the office.

Excise, in law, is an inland imposition, sometimes paid upon the consumption of the commodity, or frequently upon the retail sale, which is the last stage previous to the consumption. For more easily levying the revenue of the excise, the kingdom of England and Wales is divided into about fifty collections, some of which are called by the names of particular counties, others by the names of great towns; where one county is divided into several collections, or where a collection comprehends the contiguous parts of several counties, every such collection is subdivided into several districts, within which there is a supervisor; and each district is again subdivided into out-rides and foot-walks, within each of which there is a gauger or surveying officer.

The officers of excise are to be appointed, and may be dismissed, replaced, or altered, by the commissioners under their hands and seals; their salaries are allowed and established by the Treasury; and by 1 William and Mary, c. 24, s. 15, if it be proved by two witnesses, that any officer has demanded or taken any money, or other reward whatever, except of the King, such offender shall forfeit his office. By several statutes, no process can be sued out against any officer of excise, for any act done in the execution of his office, until one month after notice given, specifying the cause of action, and the name and abode of the person who is to begin, and the attorney who is to conduct the action; and within one month after such notice, the officer may tender amends, and plead such tender in bar; and having tendered insufficient or no amends, he may, with leave of the court, before issue joined, pay money into court.

Officers of excise are empowered to search at all times of the day, enter ware-

houses, or places for tea, coffee, &c. But private houses can only be searched upon oath of the suspicion before a commissioner or justice of peace, who can by their warrant authorise a search. The office of excise has also several excellent regulations for procuring the due attention and good conduct of their officers.

EXCITATION *of electricity*. When a non-conductor of electricity is brought into an electrified state by any other means than that of direct communication with some other electrified body, it is said to be excited; and this term is also applied to denote the like production of an electric state, even in bodies which conduct. The processes by which excitation is performed are very imperfectly understood. It is probable that they will all be hereafter found to consist in the same act; and that this will principally be governed by changes in the combination, and perhaps the temperature of bodies.

1. The electric state is produced in various bodies by heating or cooling, particularly in the tourmalin. Sulphur, chocolate, and various other substances become electrified upon congealing or becoming solid after fusion; and it is probable that this phænomenon would be found to be universal, if proper means were adopted for ascertaining the electric states. Calomel, when it fixes by sublimation against the upper surface of a glass vessel, frequently breaks through by an electric explosion. The glacial phosphoric acid was observed by Chaptal to emit strong electric sparks, while congealing. Water and other fluids become electric by evaporation. And the chemical changes of bodies have been shewn in numerous galvanic experiments, to be attended with corresponding changes of electricity. See GALVANISM.

2. The mechanical action of bodies upon each other produce electrical effects. If two metals or other conductors be brought into contact, and separated, or if they be pressed or rubbed together, electric signs are produced; and the same consequences follow, if one or both the bodies be non-conductors: but the electricity is more manifest where the non-conducting property prevails. When non-conductors are broken or torn asunder, the surfaces which were before in contact are found to be in opposite electric states; and this difference is so considerable in Muscovy talc, that bright sparks pass between them. From these facts, there is ground to suspect, that the opposite electric states prevail amongst the parts of bodies, and may perhaps be in some manner concerned in the general attraction they exert upon each other.

3. The electricity in our common machines is produced by the friction of a conducting body against a non-conductor. See MACHINE, *electric*.

The non-conductor may be a tube, a globe, a cylinder, or a plate of glass, and the conducting rubber is usually a cushion upon which a mixture of the amalgam of zinc, with a little tallow has been smeared. It is found to be a condition, that atmospheric air should be present; and if the electricity be taken off from the surface of the cylinder while it revolves, the cushion will not restore or supply the electric state, unless it be admitted to communicate with the earth. So that if an insulated conductor be placed near the cylinder, it will receive electricity for a time, though the rubber be also insulated; but the rubber itself, after assuming the negative state, will soon cease to give any more electricity to the cylinder, than the little it may obtain from the imperfect nature of its insulation. But if a communicating branch from the positive conductor be brought within a short distance of the negative cushion, the positive sparks will fly through the interval, and supply the cushion; and in this manner the circulation of electricity may, as far as yet has been determined by experiment, be kept up for an unlimited time. It seems, therefore, as if a chemical process requiring atmospheric air, and therefore of the nature of combustion, were carried on at the face of the cushion, and that a peculiar substance on which the electric state depends, becomes deposited or disposed in a different manner from that which it possessed before; and that the relative motion of the non-conducting body carried it off to a situation where it tends to its former state, and consequently advances in a current towards such parts as allow of the restoration of that state. It seems reasonable to conclude, that the disturbances of the electric state or equilibrium, and the currents by which they are restored, are in most natural operations performed through very short and good conductors; so that though in all probability they may contribute to very important results, the immediate changes elude our observation, except in a few instances, such as that of lightning and luminous meteors. And it seems from the facts to be nearly decided, that we should never have

had it in our power to exhibit the phænomenon of the electric spark, which is electricity producing ignition by breaking through a non-conductor, if we had not fortuitously experimented in circumstances where the electricity is first made to take the form of a charge, and afterwards brought into a state of considerable intensity, by separating those bodies from each other, which produced the compensation by their opposite states. Thus in the electrical machine, (see Nicholson, in the Philos. Trans. 1789,) little or no electric signs are produced by a cylinder rubbed by a very flat amalgamed leather, terminating in a neat line of contact. But this rubber and cylinder will, without any alteration, afford electricity, if a flat piece of metal, or the hand, or any other flat conductor, be held over that part of the cylinder which is in the act of receding from the cushion, even though this conductor be held at the distance of an inch or more, without touching either the cylinder or its rubber. It is proved from experiment, that the conducting body thus presented acquires the opposite state, and enables the cylinder to carry off a greater quantity of electricity in the form of a charge, the interposed air being the electric.

When the cushion is thick and rounded, as is the case with the human hand, which was first used for this purpose, the rounded part opposite the receding surface of the cylinder, performs the office of compensation; and the best application which has yet been made for this purpose, is that of a flap of silk proceeding from beneath the cushion, which assumes the negative state, so as to compensate the positive state on the cylinder, in a very considerable charge, which is conveyed by the rotation to the farther end of the silk, where it becomes uncompensated electricity upon the naked surface, at an intensity which could not otherwise have been produced.

It has not yet been determined what are the conditions and circumstances of the change which takes place by the action of the air at the face of the rubber, nor why the surface of the glass should become positive when rubbed with one kind of rubber, as for example, the human hand; and negative, if rubbed with another kind, such as cat-skin, or flannel, nor why glass, deprived of its polish, becomes negative with rubbers which would have rendered smooth glass positive. The most rational conjecture seems to be, that the surface which is most heated in consequence of its roughness, or the relative smallness of its dimensions, acquires the negative state.

There is a certain velocity of rotation, which is about five feet per second, at which the excitation of electricity by a cylinder nearly vanishes; but it returns again, the moment the velocity is diminished. Some who maintain the existence of a material cause of heat, or caloric, are disposed to consider electricity as one of the states of caloric, in which the matter of heat can pass through bodies without raising their temperature, and with much greater velocity than that by which temperature is communicated.

From the imperfect knowledge we possess respecting excitation, it is very difficult for the most experienced electricians to excite a cylinder with certainty and power. If the cylinder be greased all over with tallow, and then turned for some time in contact with the cushion, the silk flap being thrown back, and an amalgamed leather be applied and rubbed about upon the surface of the cylinder in motion, electric sparks are soon produced in abundance; and if the silk be then thrown again into contact with the cylinder the excitation will, in general, be strong; but it is seldom so strong at the first time of exciting as it proves to be after the expiration of a day or more. It seems as if the amalgam and tallow required a considerable time of working to be brought into the best state for excitation.

In order to judge of the degree of intensity of an excited cylinder, we must have recourse to some standard of the quantity of effect produced by the friction of a given surface. It has not been shewn that much, if any thing, depends on the thickness of the glass, though some kinds of glass are more excitable than others, and some not at all so. If a coated electric jar be taken of about one-twentieth of an inch in thickness (see Jar, *electric*), a cylinder or plate, moderately excited, will require fifty or sixty square feet to pass the cushion, in order to charge one foot of the coated glass, so as to explode over a rim of three inches, which is as much as can be admitted without danger of the explosion breaking through the jar. If the excitation be stronger, the charge may be made by the friction of thirty feet to one of the jar; and the strongest excitation the editor has ever known, has been by the friction of fourteen square feet of a cylinder to charge one foot

of glass. But as the labour increases by adhesion of the cushion, the stronger the excitation, it seems as if the strength of a man would be more profitably employed in turning two or more plates, or cylinders, at the intensity of thirty feet, than at any higher intensity; besides which, this power is less variable, and may last five or six hours without requiring fresh amalgam.

The vulgar notion of electricity is, that it is fire which passes in a spark from one body to another. From its passage through dense conductors, as well as through the air, it seems to move with extreme velocity; and this may be sufficient, without supposing it to be essentially luminous, to account for the ignited appearance it affords, in all non-conductors, whether air, or oil, or glass, or wood, &c. and even in metal, when the conductor is small. If oxygen be present, these bodies will have their combustible parts burned; and if not, a decomposition of those parts which are ignited may ensue.

EXCLAMATION, in rhetoric, a figure that expresses the violent and sudden breaking out, and vehemence of any passion. Such is that in the second book of Milton's "Paradise Lost:"

> "O unexpected stroke, worse than of death!
> Must I thus leave thee, Paradise? Thus leave
> Thee, native soil; these happy walks and shades,
> Fit haunt of gods!"

Other figures are the language of some particular passion, but this expresses them all. It is the voice of nature, when she is in concern and transport.

EXCLUSION, or *Bill of Exclusion*, a bill proposed about the close of the reign of King Charles II. for excluding the Duke of York, the King's brother, from the throne, on account of his being a papist.

Exclusion, in mathematics, is a method of coming at the solution of numerical problems, by previously throwing out of our consideration such numbers as are of no use in solving the question.

EXCLUSIVE is sometimes used adjectively, thus: "A patent carries with it an exclusive privilege;" and sometimes adverbially, as, "He sent him all the numbers from N° 145 to N° 247 exclusive;" that is, all between these two numbers, which themselves were excepted.

Exclusive *propositions*, in logic, are those where the predicate so agrees with its subject, as to exclude every other. Thus, "Virtue alone constitutes nobility," is an exclusive proposition.

EXCOECARIA, in botany, a genus of the Dioecia Triandria class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: ament naked; calyx and corolla, none; styles three; capsule, tricoccous. There are two species; *viz.* E. agallocha and E. Cochin Chinensis.

EXCOMMUNICATION, in law, is of two kinds, the less and the greater, which last is the highest ecclesiastical censure which can be pronounced; for thereby the party is excluded from the body of the church, and disabled from bringing any action in the common law courts; he is also disabled to serve on juries, or to be a witness in any cause; he cannot be attorney or procurator for another; he is to be turned out of the church by the churchwardens, and not to be allowed christian burial. He may also, in some cases, be imprisoned until he submits to the ecclesiastical jurisdiction, as in case of refusing to answer to a suit for tithes.

EXCORIATION, in medicine and surgery, the galling or rubbing off of the cuticle. To remedy this, the parts affected may be washed often with warm water, and sprinkled with drying powders, as chalk, hartshorn, but especially tutty, lapis calaminaris, and ceruse, which may be tied loosely in a rag, and the powder shook out on the disordered places.

EXCREMENT. See Feces.

EXCRESCENCE, in surgery, denotes every preternatural tumour which arises upon the skin, either in the form of a wart or tubercle.

EXCRETION, or Secretion, in medicine, a separation of some fluid, mixed with the blood by means of the glands. See Secretion.

EXCRETORY, in anatomy, a term applied to certain little ducts or vessels, destined for the reception of a fluid, secreted in certain glandules, and other viscera, for the excretion of it in the appropriated places.

EXECUTION, in law, is a judicial writ, grounded on the judgment of the court whence it issues; and is supposed to be granted by the court, at the request of the party at whose suit it is issued, to give him satisfaction on the judgment which he hath obtained; and therefore an execution cannot be sued out in one court, upon a judg-

ment obtained in another. These are of different sorts, according to the nature of the action: in actions where money is recovered, as a debt or damages, they are of five sorts; 1, against the body of the defendant; 2, or against his goods or chattels; 3, against his goods and the profits of his lands; 4, against the goods and the possession of his lands; 5, against all three, his body, lands, and goods.

Execution *of criminals*, must be according to the judgment; and the King cannot alter a judgment from hanging to beheading, because no execution can be warranted, unless it be pursuant to the judgment.

This being the completion of human punishment, in all cases, as well capital as otherwise, must be performed by the legal officer, the sheriff or his deputy. Murderers are to be executed the day next but one after conviction, unless it be Sunday, and anatomized; for which reason they are generally tried on a Friday.

Execution, in music, a term applicable to every species of musical performance; but more particularly used to express a facility of voice or finger in running rapid divisions, and other difficult and intricate passages: it includes, in a general sense, taste, feeling, grace, and expression.

EXECUTOR, in law, is a person appointed by the testator to carry into execution his will and testament after his decease. The regular mode of appointing an executor, is by naming him expressly in the will; but any words indicating an intention of the testator to appoint an executor, will be deemed a sufficient appointment.

Any person capable of making a will is also capable of being an executor; but in some cases, persons who are incapable of making a will, may nevertheless act as executors, as infants, or married women; to obviate, however, inconveniences which have occurred respecting the former, it is enacted by stat. 38 Geo. III. c. 89, that where an infant is sole executor, administration, with the will annexed, shall be granted to the guardian of such infant, or such other person, as the spiritual court shall think fit, until such infant shall have attained the age of 21; when, and not before, probate of the will shall be granted him. An executor derives his authority from the will, and not from the probate, and is therefore authorised to do many acts in execution of the will, even before it is proved, such as releasing, paying, or receiving of debts, assenting to licences, &c.; but he cannot proceed at law until he have obtained probate. If an executor die before probate, administration must be taken out with the will annexed; but if an executor die, his executor will be executor to the first testator, and no fresh probate will be needed: it will be sufficient if one only of the executors prove the will; but if all refuse to prove, they cannot afterwards administer, or in any respect act as executors. If an executor become a bankrupt, the court of Chancery will appoint a receiver of the testator's effects, as it will also upon the application of a creditor, if he appear to be wasting the assets. If an executor once administer, he cannot afterwards renounce. If an executor refuse to take upon him the execution of the will, he shall lose his legacy under it. If a creditor constitute his debtor his executor, this is at law a discharge of the debt, whether the executor act or not, provided however, there be assets sufficient to discharge the debts of the testator: in equity, however, there are some exceptions to this rule. The first duty of an executor or administrator is, to bury the deceased in a suitable manner; and if the executor exceed what is necessary in this respect, it will be a waste of the substance of the testator. The next thing to be done by the executor, is to prove the will, which may be done either in the common form, by taking the oath to make due distribution, &c.; or in a more solemn mode, by witnesses to its execution. By stat. 37 Geo. III. c. 9, s. 10, every person who shall administer the personal estate of any person dying, without proving the will of the deceased, or taking out letters of administration within six calendar months after such person's decease, shall forfeit 50*l*.

If all the goods of the deceased lie within the same jurisdiction, the probate is to be made before the ordinary or bishop of the diocese, where the deceased resided; but if he had goods and chattels to the value of 5*l*. in two distinct dioceses or jurisdictions, the will must be proved before the metropolitan or archbishop of the province in which the deceased died. An executor, by virtue of the will of the testator, has an interest in all the goods and chattels, whether real or personal, in possession or in action of the deceased; and all goods and effects coming to his hands will be the assets to make him chargeable to creditors and legatees. An executor or administrator stands

personally responsible for the due discharge of his duty; if, therefore, the property of the deceased be lost, or through his wilful negligence become otherwise irrecoverable, he will be liable to make it good; and also where he retains money in his hands longer than is necessary, he will be chargeable not only with the interest but costs, if any have been incurred.

But one executor shall not be answerable for money received, or detriment occasioned by the other, unless it has been by some act done between them jointly. An executor or administrator has the same remedy for recovering debts and duties, as the deceased would have had if living. Neither an executor nor administrator can maintain any action for a personal injury done to the deceased, when such injury is of such a nature for which damages may be received; in actions, however, which have their origin in breach of promise, although the suit may abate by the death of the party, yet it may be revived either by his executors or administrators, who may also sue for rent in arrear, and due to the deceased in his life-time. By the custom of merchants, an executor or administrator may indorse over a bill of exchange, or promissory note. An executor or administrator may also, on the death of a lessee for years, assign over the lease, and shall not be answerable for rent after such assignment, nor shall he be liable for rent due after the lessee's death, from premises which in his life-time he had assigned to another.

An executor, or administrator, is bound only by such covenants in a lease, as are said to run with the land. The executor, or administrator, previous to the distribution of the property of the deceased, must take an inventory of all his goods and chattels, which must, if required, be delivered to the ordinary upon oath. He must then collect, with all possible convenience, all the goods and effects contained in such an inventory; and whatever is so recovered that is of a saleable nature, and can be converted into money, is termed assets, and makes him responsible to such amount to the creditors, legatees, and kindred of the deceased.

The executor, or administrator, having collected in the property, is to proceed to discharge the debts of the deceased, which he must do according to the following priorities, otherwise he will be personally responsible. 1. Funeral expences, charges of proving the will, and other expenditures incurred by the execution of his trust. 2. Debts due to the King on record, or by speciality. 3. Debts due by particular statutes, as by 30 Geo. II. c. 23; forfeitures for not burying in woollen, money due for poor-rates, and money due to the post-office. 4. Debts of record, as judgments, statutes, recognizances, and those recognized by a decree of a court of equity, and debts due on mortgage. 5. Debts on special contract, as bonds or other instruments under seal; and also rent in arrear. 6. Debts on simple contract, *viz.* such as debts arising by mere verbal promise, or by writing not under seal, as notes of hand, servants' wages, &c.

The executor is bound at his peril to take notice of debts on record, but not of other special contracts, unless he receives notice. If no suit be actually commenced against an executor, or administrator, he may pay one creditor in equal degree the whole debt, though there should be insufficient remaining to pay the rest; and even after the commencement of a suit, he may, by confessing judgment to other creditors of the same degree, give them a preference. Executors and administrators are also allowed, amongst debts of equal degree, to pay themselves first; but they are not allowed to retain their own debt to the prejudice of others in a higher degree; neither shall they be permitted to retain their own debts, in preference to that of their co-executor, or co-administrator, of equal degree, but both shall be charged in equal proportion. A mortgage made by the testator must be discharged by the representative out of the personal estate, if there be sufficient to pay the rest of the creditors and legatees: where such mortgage, however, was not incurred by the deceased, it is not payable out of the personal estate.

EXECUTORY *devise*, is defined a future interest, which cannot vest at the death of a testator, but depends upon some contingency, which must happen before it can vest: it is called so to distinguish it from a remainder from which it differs in being less strictly restrained by technical rules.

EXEGESIS, a discourse by way of explanation or comment upon any subject.

EXEMPLIFICATION *of letters patent*, a transcript or duplicate of them, made from the inrolment thereof, and sealed with the great seal. These exemplifications are by statute equally effectual, and may be pleaded as well as the originals. One may exemplify a patent under the great seal in Chancery; also any record, or judgment,

in any of the courts at Westminster, under the seal of each court; which exemplifications may be given in evidence to a jury. It is held that nothing but matter of record ought to be exemplified.

EXERCISE, among physicians, such an agitation of the body as produces salutary effects in the animal economy. Exercise may be said to be either active or passive. The active is walking, hunting, dancing, playing at bowls and the like; as also speaking, and other labour of the body and mind; the passive is riding in a coach, on horseback, or in any other manner. Exercise may be continued to a beginning of weariness, and ought to be used before dinner, in a pure light air; for which reason, journies and going into the country contribute greatly to preserve and re-establish health.

Exercise, in military affairs, is the ranging a body of soldiers in form of battle, and making them perform the several motions and military evolutions with different management of their arms, in order to make them expert therein.

Exercise is the first part of the military art, and from it the greatest advantage may be expected, in the expertness with which men become capable of loading and firing, and their learning and attention to act in conformity with those around them. It is not from numbers, or from inconsiderate valour, that victory can rationally be hoped for. In battle the triumph is usually derived from a knowledge of arms, and a strict attention to discipline.

Exercise *of the infantry*, includes the use of the firelock and practice of the manœuvres for regiments of foot, according to regulations used by authority. The beauty of all exercise and marching consists in seeing a soldier carry his arms well, keep his firelock steady, and the whole body without constraint. Every motion should be performed with life, and with the greatest regard to exactness, and in order to these, a regiment should never be under arms longer than two hours at a time.

Exercise *of the cavalry*, is of two sorts, *viz.* on horseback and on foot. The officers commanding squadrons must be careful to form with great celerity, and preserve just order and distances. The men must keep a steady seat upon their horses, and have their stirrups of a fit length.

Exercise *of the artillery*, is the method of teaching the regiments of artillery the use and practice of all the various machines of war, *viz.* Exercise of the light field-pieces teaches the men to load, ram, and sponge the guns well; to elevate them according to the distance, by the quadrant and screw; to judge of distances and elevations without the quadrant; how to use the port-fire, match, and tubes for quick firing; how to fix the drag-ropes, and use them in advancing, retreating, and wheeling with the field-pieces; how to fix and unfix the trail of the carriage on the limbers, and how to fix and unfix the boxes for grape-shot on the carriages of each piece.

Exercise *of the garrison and battering artillery*, is to teach the men how to load, ram, and sponge; how to handle the handspikes in elevating and depressing the metal to given distances, and for ricochet; how to adjust the coins, and work the gun to its proper place; and how to point and fire with exactness, &c.

Exercise *for the mortar*, is of two different sorts, *viz.* with powder and shells unloaded, and with powder and shells loaded; each of which is to teach the men their duty, and to make them handy in using the implements for loading, pointing, traversing, and firing, &c.

Exercise *of the howitzer*, differs but little from the mortar, except that it is liable to various elevations; whereas that of the mortar is fixed to an angle of 45°; but the men should be taught the method of ricochet-firing, and how to practice with grape-shot; each method requiring a particular degree of elevation.

Exercises are also understood of what young gentlemen or cadets learn in the military academies and riding-schools; such as fencing, dancing, riding, the manual exercise, &c. The late establishment at High Wycomb is calculated to render young officers perfectly competent to all the duties of military service, provided they have been previously instructed in the first rudiments. Officers are there taught and exercised in the higher branches of tactics and manœuvres.

EXERGUM, among antiquarians, a little space around or without the figures of a medal, left for the inscription, cypher, device, date, &c.

EXHALATION, a general term for all the effluvia or steams raised from the surface of the earth in form of vapour. Some distinguish exhalations from vapours, expressing by the former all steams emitted from solid bodies, and by the latter the steams raised from water and other fluids.

EXHAUSTED *receiver*, a glass, or other

vessel, out of which the air hath been drawn by means of the air-pump. See Pneumatics.

EXHAUSTION, in mathematics, a method in frequent use among the ancient mathematicians, as Euclid, Archimedes, &c. that proves the equality of two magnitudes, by a deduction *ad absurdum*, in supposing that, if one be greater or less than the other, there would follow an absurdity.

This is founded upon what Euclid saith in his tenth book, *viz.* that those quantities, whose difference is less than any assignable one, are equal. For if they were unequal, be the difference never so small, yet, it may be so multiplied, as to become greater than either of them: if not so, then it is really nothing. This he assumes in the proof of the 1st proposition of book 10, which is, that if from the greater of two quantities, you take more than its half, and from the remainder more than its half, and so continually, there will, at length, remain a quantity less than either of those proposed.

On this foundation they demonstrate, that if a regular polygon of infinite sides be inscribed in, or circumscribed about a circle; the space, that is the difference between the circle and the polygon, will, by degrees, be quite exhausted, and the circle be equal to the polygon.

EXHIBITION, a benefaction settled for the benefit of scholars in the universities, that are not on the foundation.

EXIGENT, in law, a writ or part of the process of outlawry on civil actions.

EXISTENCE, that whereby any thing has an actual essence, or is said to be. Mr. Locke says, "that we arrive at the knowledge of our own existence by intuition; of the existence of God by demonstration; and of other things by sensation. As for our own existence," continues that great philosopher, "we perceive it so plainly that it neither needs, nor is capable of any proof. I think, I reason, I feel pleasure and pain; can any of these be more evident to me than my own existence? If I doubt of all other things, that very doubt makes me perceive my own existence, and will not suffer me to doubt it. If I know I doubt, I have as certain a perception of the thing doubting, as of that thought which I call doubt: experience then convinces us that we have an intuitive knowledge of our own existence."

From the knowledge of our own existence, Mr. Locke deduces his demonstration of the existence of a God.

It has been a subject of great dispute whether external bodies have any existence but in the mind, that is, whether they really exist, or exist in idea only: the former opinion is supported by Mr. Locke, and the latter by Dr. Berkeley. "The knowledge of the existence of other things, or things without the mind, we have only by sensation: for there being no necessary connection of real existence with any idea a man hath in his memory, nor of any other existence but that of God, with the existence of any particular man; no particular man can know the existence of any other being, but only, when, by operating upon him, it makes itself be perceived by him. The having the idea of any thing in our mind no more proves the existence of that thing than the picture of a man evidences his being in the world, or the visions of a dream make a true history. It is, therefore, the actual receiving of ideas from without that gives us notice of the existence of other things, and makes us know that something does exist at that time without us which causes that idea in us, though perhaps we neither know nor consider how it does it. This notice, which we have by our senses, of the existence of things without us, though it be not altogether so certain as intuition and demonstration, yet deserves the name of knowledge, if we persuade ourselves that our faculties act and inform us right concerning the existence of those objects that affect them: but besides the assurance we have from our senses themselves, that they do not err in the information they give us of the existence of things without us, we have other concurrent reasons; as, first, it is plain these perceptions are produced in us by external causes affecting our senses, because those that want the organs of any sense never can have the ideas belonging to that sense produced in their minds. Secondly, because we find sometimes that we cannot avoid the having those ideas produced in our minds. When my eyes are shut I can, at pleasure, recal to my mind the ideas of light, or the sun, which former sensations had lodged in my memory; but if I turn my eyes towards the sun I cannot avoid the ideas which the light or the sun then produces in me; which shews a manifest difference between those ideas laid up in the memory, and such as force themselves upon us, and we cannot avoid having; besides, there is nobody who doth not perceive the difference in himself between actually looking on the sun and contemplat-

ing the idea he has of it in his memory; and therefore he hath certain knowledge that they are not both memory or fancy. Thirdly, add to this, that many ideas are produced in us with pain, which we afterwards remember without the least offence: thus, the pain of heat or cold, when the idea of it is revived in our minds, give us no disturbance, which, when felt, was very troublesome; and we remember the pain of hunger, thirst, head-ach, &c. without any pain at all, which would either never disturb us, or else constantly do it, as often as we thought of it, were there no more but ideas floating in our minds, and appearances entertaining our fancies, without the real existence of things affecting us from abroad. Fourthly, our senses, in many cases, bear witness to the truth of each others report concerning the existence of sensible things without us: he that doubts when he sees a fire, whether it be real, may, if he pleases, feel it too, and by the exquisite pain may be convinced that it is not a bare idea, or phantom."

Dr. Berkeley, on the other hand, contends that external bodies have no existence but in the mind perceiving them, or that they exist no longer than they are perceived: his principal arguments, which several others, as well as himself, esteem a demonstration of this system, are as follow: "That neither our thoughts, passions, or ideas formed by the imagination, exist without the mind is allowed; and that the various sensations impressed on the mind, whatever objects they compose, cannot exist otherwise than in a mind perceiving them, is equally evident. This appears from the meaning of the term exist, when applied to sensible things: thus, the table I write on exists, *i. e.* I see and feel it; and were I out of my study I should say it existed, *i.e.* that were I in my study I should see and feel it as before. There was an odour, *i.e.* I smelt it, &c; but the existence of unthinking beings without any relation to their being perceived is unintelligible: their *esse* is *percipi*." Then to shew that the notion of bodies is grounded on the doctrine of abstract ideas, "What," he asks, "are light and colours, heat and cold, extension and figure, in a word, the things we see and feel, but so many sensations, notions, ideas, or impressions on the sense; and is it possible to separate, even in thought, any of these from perception? The several bodies then that compose the frame of the world have not any subsistence without a mind: their *esse* is to be perceived or known; and if they are not perceived by me, nor by any other thinking being, they have no shadow of existence at all: the things we perceive are colour, figure, motion, &c. that is, the ideas of those things; but has an idea any existence out of the mind? To have an idea is the same thing as to perceive; that, therefore, wherein colour, figure, &c. exist, must perceive them. It is evident, therefore, that there can be no unthinking substance, or substratum of those ideas. But you may argue, if the ideas themselves do not exist without the mind, there may be things like them, whereof they are copies or resemblances, which exist without the mind. It is answered, an idea can be like nothing but an idea, a colour or figure can be nothing else but another colour or figure. It may be farther asked, whether those supposed original or external things, whereof our ideas are the pictures, be themselves perceivable or not? If they be not, I appeal to any one whether it be sense to say a colour is like somewhat which is invisible, hard or soft, like somewhat untangible, &c. Some distinguish between primary and secondary qualities, the former, *viz.* extension, solidity, figure, motion, rest, and number, have a real existence out of the mind; for the latter, under which come all other sensible qualities, as colours, sounds, tastes, &c. they allow the ideas we have of them are not resemblances of any thing without the mind, or unperceived, but depend on the size, texture, motion, &c. of the minute particles of matter. Now it is certain that those primary qualities are inseparably united with the other secondary ones, and cannot even in thought be abstracted from them, and therefore must only exist in the mind. Again, great or small, swift or slow, are allowed to exist no where without the mind, being merely relative, and changing as the frame or position of the organ changes: the extension, therefore, that exists without the mind is neither great nor small, the motion neither swift nor slow, *i. e.* they are nothing. That number is a creature of the mind is plain, (even though the other qualities were allowed to exist) from this, that the same thing bears a different denomination of number as the mind views it with different respects: thus, the same extension is 1, 3, or 36, as the mind considers it, with reference to a yard, a foot, or an inch.

"In effect, after the same manner, as the modern philosophers prove colours, tastes

Fig.1. **Erinaceus** *Europæus: Common Hedge-hog_Fig.2.* **E.** *Malaccensis: Malacca hedge hog_Fig.3.* **Hystrix** *cristata: Crested Porcupine_ Fig.4.* **H.** *prehensilis: Brasilian Porcupine Fig.5.* **Hyrax** *capensis: Cape Hyrax.*

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&c. to have no existence in matter, or without the mind, the same thing may be proved of all sensible qualities whatever: thus, they say, heat and cold are only the affections of the mind, not at all patterns of real beings existing in corporeal substances, for that the same body which seems cold to one hand seems warm to another. Now, why may we not as well argue that figure and extension are not patterns or resemblances of qualities existing in matter, because, to the same eye, at different stations, or to eyes of different structure, at the same station, they appear various? Again, sweetness, it is proved, does not exist in the thing sapid, because the thing remaining unaltered, the sweetness is changed to bitterness, as in a fever, or by any otherwise vitiated palate. Is it not as reasonable to say that motion does not exist out of the mind, since if the succession of ideas in the mind become sinister, the motion, it is acknowledged, will appear slower, without any external alteration? Again, were it possible for solid figured bodies to exist out of the mind, yet it were impossible for us ever to know it: our senses, indeed, give us sensations of ideas, but do not tell us that any thing exists without the mind, or unperceived, like those which are perceived; this the materialists allow. No other way therefore remains, but that we know them by reason's inferring their existence from what is immediately perceived by sense; but how should reason do this, when it is confessed there is not any necessary connection between our sensations and these bodies? It is evident, from the phænomena of dreams, phrensies, &c. that we may be affected with the ideas we now have, though there were no bodies existing without them; nor does the supposition of external bodies at all forward us in conceiving how our ideas should come to be produced."

EXOACANTHA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: involute spiny; involucle halved, with unequal rays; flowers all hermaphrodite, with equal, inflex, heart-shaped petals; seeds ovate, striate. There is but one species, *viz.* E. heterophylla, found by Billardiere near Nazareth.

EXOCŒTUS, the *flying fish*, in natural history, a genus of fishes of the order Abdominales. Generic character: head scaly; mouth without teeth; jaws connected on each side; gill membrane, ten-rayed; pectoral fins very long and large, and giving, to a certain degree, the power of flight. There are three species. We shall particularly notice the E. exilien, or the Mediterranean flying-fish. This is about fourteen inches in length, and is found principally in the Mediterranean and Atlantic Seas, frequently alone, and sometimes in small companies. By the extraordinary length of its pectoral fins it is enabled to quit the water and support a flight, about three feet above the surface, for the distance of eighty or a hundred yards, after which it is obliged to return to the water and moisten its fins, which, even in this short progress, become hard and dry. These fishes are persecuted by the dorado under the water, and by the gull, or albatross, above the surface of it, and thus often escape destruction by the one only to incur it from the other. This faculty of maintaining short flights in the air is possessed by several other fishes, particularly by the scorpæna and the trigla. The air-bladder of the flying-fish is extremely large, and, of consequence, highly assisting to its aerial progress. The roe of this fish is reported to be highly caustic; the smallest quantity applied to the tongue producing some degree of excoriation. For a representation of the oceanic flying-fish, see Pisces, Plate IV, fig. 2.

EXORDIUM, in rhetoric, is the preamble or beginning, serving to prepare the audience for the rest of the discourse. Exordiums are of two kinds, either just and formal, or vehement and abrupt. The last are most suitable on occasions of extraordinary joy, indignation, or the like. All exordiums should be composed with a view to captivate the good will, or attract the attention of the audience. The first may be done by paying them some compliment: thus St. Paul, "I think myself happy, king Agrippa, because I shall answer for myself this day before thee, touching all the things whereof I am accused with the Jews, especially because I know thee to be expert in all customs and questions which are among the Jews."

The requisites in an exordium are, 1. Propriety, whereby it becomes of a piece with the subject, and matches it as a part does a whole: in this the Greeks were very defective. 2. Modesty, which very much recommends the orator to the favour of his audience. And, 3. Brevity, not amplified or swelled with a detail of circumstances.

EXOTERIC, and Esoteric, terms denoting external and internal, and applied

to the double doctrine of the ancient philosophers: the one was public or exoteric, the other secret or esoteric. The first was that which they taught openly to the world, the latter was confined to a small number of disciples. See PERIPATETICS.

EXOTIC, an appellation denoting a thing to be the produce of foreign countries. Exotic plants of the hot climates are very numerous, and require the utmost attention of the gardener to make them thrive with us.

EXPANSION, in natural philosophy, the enlargement or increase of bulk in bodies, chiefly by means of heat. This is one of the most general effects of caloric, being common to all bodies whatever, whether solid or fluid, or in an aeriform state. In some cases bodies seem to expand as they grow cold, as water in the act of freezing; this, however, is known to be no exception to the general rule, but is owing to the arrangement of the particles, or to crystallization, and is not a regular and gradual expansion like that of metals, or other solid substances by means of heat. In various metals likewise an expansion takes place in passing from a fluid to a solid state, which is accounted for in the same way. The expansion of solids is exhibited by the PYROMETER (which see); a rod of iron, for instance, becomes sensibly longer and larger in all its dimensions in passing from a low to a high state of temperature. The expansion of fluids is shewn by the thermometer, and is the principle upon which that useful instrument is constructed; by immersing a thermometer into hot water, the mercury, or other fluid, contained in it immediately expands. See THERMOMETER. The degree of expansion produced in different liquids, varies very considerably. In general, the denser the fluid, the less the expansion; water expands more than mercury, and alcohol, which is lighter than water, expands more than water. The expansion of æriform fluids may be exhibited by bringing a bladder, partly filled with air, and the neck closely tied, near the fire; the bladder will soon be distended, and will, if the heat be strong enough, burst. Metals expand in the following order, those that expand most are placed first: zinc, lead, tin, copper, bismuth, iron, platina.

EXPECTATION *of life*, a term used by the writers on life annuities and reversions, and which, according to Dr. Price, signifies the mean continuance of any given single, joint, or surviving lives, according to any given table of observations: that is, the number of years which, taking them one with another, they actually enjoy, and may be considered as sure of enjoying; those who live or survive beyond that period, enjoying as much more time, in proportion to their number, as those who fall short of it enjoy less. See LIFE, *duration of.*

EXPECTORANTS, an appellation given to those medicines which facilitate the discharging the contents of the lungs.

EXPECTORATION, the act of evacuating or bringing up phlegm, or other matters out of the trachea, lungs, &c. by coughing, hauking, spitting, &c.

EXPEDITION, in military affairs, is chiefly used to denote a voyage or march against an enemy, the success of which depends on rapid and unexpected movements. No rules have, or probably can be given for the application of expeditions generally; they depend on circumstances that cannot be foreseen; they seem to depend on the following maxims: 1. Secresy of preparation and concealment of design. 2. The means must be proportional to the end. 3. There must be an accurate knowledge of the state and situation of the country. 4. The plan must be well arranged, and the commander perfectly adapted to the particular sort of business.

EXPERIENCE, a kind of knowledge acquired by long use, without any teacher. Mr. Locke says that men receive all the materials of knowledge from experience and observation. Experience then consists in the ideas of things we have seen or read, which the judgment has reflected on, to form itself a rule or method.

EXPERIMENTAL *philosophy*, that philosophy which proceeds on experiments, which deduces the laws of nature, and the properties and powers of bodies, and their actions upon each other, from sensible experiments and observations. The business of experimental philosophy is to inquire into and to investigate the reasons and causes of the various appearances or phænomena of nature, and to make the truth or probability thereof obvious and evident to the senses, by plain, undeniable, and adequate experiments, representing the several parts of the grand machinery and agency of nature.

In our inquiries into nature, we are to be conducted by those rules and maxims which are found to be genuine, and consonant to a just method of physical reasoning; and these rules of philosophizing are by

the greatest master in science, Sir Isaac Newton, reckoned four, which are as follows:

1. More causes of natural things are not to be admitted, than are both true, and sufficient to explain the phænomena; for nature does nothing in vain, but is simple, and delights not in superfluous causes of things.

2. And, therefore, of natural effects of the same kind, the same causes are to be assigned, as far as it can be done; as of respiration in man and beasts, of the descent of stones in Europe and America, of light in a culinary fire and in the sun, and of the reflection of light in the earth and in the planets.

3. The qualities of natural bodies which cannot be increased or diminished, and agree to all bodies in which experiments can be made, are to be reckoned as the qualities of all bodies whatsoever: thus, because extension, divisibility, hardness, impenetrability, mobility, the vis intertiæ, and gravity, are found in all bodies which fall under our cognizance or inspection, we may justly conclude they belong to all bodies whatsoever, and are therefore to be esteemed the original and universal properties of all natural bodies.

4. In experimental philosophy, propositions collected from the phænomena by induction, are to be deemed (notwithstanding contrary hypotheses) either exactly or very nearly true, till other phænomena occur, by which they may be rendered either more accurate, or liable to exception. This ought to be done, lest arguments of induction should be destroyed by hypothesis.

These four rules of philosophizing are premised by Sir Isaac Newton to his third book of the "Principia;" and more particularly explained by him in his "Optics," where he exhibits the method of proceeding in philosophy, the first part of which is as follows:

"As in mathematics, so in natural history, the investigation of difficult things, by way of analysis, ought always to precede the method of composition. This analysis consists in making experiments and observations, and in drawing general conclusions from them by induction (*i. e.* reasoning from the analogy of things by natural consequence) and admitting no objections against the conclusions, but what are taken from experiments or certain truths. And although the arguing from experiments and observation, by induction, be no demonstration of general conclusions, yet it is the best way of arguing which the nature of things admits of, and may be looked on as so much the stronger, by how much the induction is more general; and if no exception occur from phænomena, the conclusion may be pronounced generally; but if, at any time afterwards, any exception shall occur from experiments, it may then be pronounced with such exceptions: by this way of analysis we may proceed from compounds to ingredients, and from motions to the causes producing them; and, in general, from effects to their causes; and from particular causes to more general ones, till the argument ends in the most general: this is the method of analysis. And that of synthesis, or composition, consists in assuming causes, discovered and established as principles, and by them explaining the phænomena, proceeding from them, and proving the explanations." See ACOUSTICS, AEROSTATION, ELECTRICITY, HYDROSTATICS, MAGNETISM, MECHANICS, OPTICS, PNEUMATICS, &c. &c.

EXPERIMENTUM *crucis*, a capital, leading, or decisive experiment; thus termed, either on account of its being like a cross or direction post, placed in the meeting of several roads, guiding men to the true knowledge of the nature of that thing they are inquiring after; or, on account of its being a kind of torture, whereby the nature of the thing is, at it were, extorted by force.

EXPIRATION, in physic, that part of respiration whereby the air is expelled, or driven out of the lungs. See PHYSIOLOGY.

EXPLOSION, in natural philosophy, a sudden and violent expansion of an aerial, or other elastic fluid, by which it instantly throws off any obstacle that happens to be in the way, sometimes with incredible force, and in such a manner as to produce the most astonishing effects. It differs from expansion in this, that the latter is a gradual and continued power, acting uniformly for some time, whereas, the former is always sudden, and only of momentary duration. The expansions of solid bodies do not terminate in violent explosions, on account of their slowness, and the small space through which the metal, or other expanding substance, moves. Thus wedges of dry wood driven into stone, and wetted, will cleave the most solid blocks, but they never throw the parts to any distance, as

is the case with gunpowder; but the expansion of elastic fluids will burst solid substances, and throw the fragments a great way off: for this two reasons have been assigned: 1. The immense velocity with which aerial fluids expand, when suddenly affected with high degrees of heat: and 2. The great celerity with which they acquire heat, and are affected by it. As an example, air when heated as much as iron, when brought to a white heat, is expanded to four times its bulk, but the metal itself will not be expanded the 500dth part of the space. In the case of gunpowder, which is well known as an explosive substance, the velocity with which the flame moves, is estimated at 7000 feet in a second. Hence the impulse of the fluid is inconceivably great, and the obstacles on which it strikes are hurried off with vast velocity, *viz.* at the rate of 27 miles per minute. The velocity of the bullet is also promoted by the sudden propagation of the heat through the whole body of air, as soon as it is extricated from the materials of which the gunpowder is made, so that it strikes at once. Hence it has been inferred, that explosion depends first on the quantity of elastic fluid to be expanded: secondly, on the velocity it acquires by a certain degree of heat; and thirdly, on the celerity with which the degree of heat affects the whole expansile fluid.

EXPONENT, in algebra, is a number placed over any power or involved quantity, to shew to what height the root is raised: thus, 2 is the exponent of x^2, and 4 the exponent of x^4, or $xxxx$. The rule for dividing powers of the same quantity, is to subtract the exponents, and make the difference the exponent of the quotient: if, therefore, a lesser power is divided by a greater, the exponent of the quotient must, by this rule, be negative: thus, $\frac{a^4}{a^6} = a^{4-6} = a^{-2}$. But $\frac{a^4}{a^6} = \frac{1}{a^2}$; and hence $\frac{1}{a^2}$ is expressed by a^2, with a negative exponent. It is also obvious that $\frac{a}{a} = a^{1-1} = a^0$; but $\frac{a}{a} = 1$, and therefore $a^0 = 1$. After the same manner, $\frac{1}{a} = \frac{a^0}{a} = a^{0-1} = a^{-1}$; $\frac{1}{aa} = \frac{1}{a^2} = a^{0-2} = a^{-2}$; $\frac{1}{aaa} = a^{0-3} = a^{-3}$; so that the quantities, a, 1, $\frac{1}{a}$, $\frac{1}{a^2}$, $\frac{1}{a^3}$, $\frac{1}{a^4}$, &c. may be expressed thus, a^1, a^0, a^{-1}, a^{-2}, a^{-3}, a^{-4}, &c. These are called the negative powers of a, which have negative exponents; but they are at the same time positive powers of $\frac{1}{a}$, or a^{-1}.

EXPONENT *of a ratio*, is the quotient arising from the division of the antecedent by the consequent: thus, in the ratio of 5 to 4, the exponent is $1\frac{1}{4}$; but the exponent of 4 : 5, is $\frac{4}{5}$. If the consequent be unity, the antecedent itself is the exponent of the ratio: thus the exponent of the ratio 4 : 1 is 4. Wherefore the exponent of a ratio is to unity as the antecedent is to the consequent. Although the quotient of the division of the antecedent by the consequent, is usually taken for the exponent of a ratio, yet in reality the exponent of a ratio ought to be a logarithm. And this seems to be more agreeable to Euclid's definition of duplicate and triplicate ratios, in his fifth book. For 1, 3, 9, are continual proportionals; now if $\frac{1}{3}$ be the exponent of the ratio of 1 to 3, and $\frac{3}{9}$ or $\frac{1}{3}$ the exponent of the ratio of 3 to 9; and $\frac{1}{9}$ the exponent of the ratio of 1 to 9; and since, according to Euclid, if three quantities be proportional, the ratio of the first to the third is said to be the duplicate of the ratio of the first to the second, and of the second to the third; therefore according to this, $\frac{1}{9}$ must be the double of $\frac{1}{3}$, which is very false. But it is well known, the logarithm of the ratio of 1 to 9, that is, the logarithm of 9, is the double of the ratio of 1 to 3, or 3 to 9, that is, the logarithm of 3. From whence it appears that logarithms are more properly the exponents of ratios, than numerical quotients; and Dr. Halley, Mr. Cotes, and others, are of the same opinion.

EXPONENT, is also used in arithmetic, in the same sense as index or logarithm.

EXPONENTIAL *curve*, is that whose nature is expressed by an exponential equation. The area of any exponential curve, whose nature is expressed by this exponential equation $x^x = y$ (making $1 + v = x$) will be $\frac{1}{0.1.2}v^2 + \frac{1}{0.1.2.3}v^3 - \frac{1}{0.1.2.3.4}v^4 + \frac{1}{0.1.2.3.4.5}v^5 - \frac{1}{0.1.2.3.4.5.6}v^6$, &c.

EXPONENTIAL *equation*, is that wherein

there is an exponential quantity. See the next article.

Exponential *quantity*, is a quantity whose power is a variable quantity, as x^x, a^x. Exponential quantities are of several degrees and orders, according as the exponents themselves are more or less involved. If the exponent be a simple quantity, as z^y, it is called an exponential of the first or lowest degree; but when the exponent itself is an exponential of the first degree, as z^{y^x}, it is called an exponential of the second degree. In like manner, if the exponent itself be an exponential of the second degree, as $x^{y^{x^0}}$, it is called an exponential of the third degree, &c.

EXPORTATION, the act of sending goods out of one country into another. In modern times it has been the principal object of commercial policy, in almost every country, to encourage exportation, except with respect to a few particular articles; the export of manufactured goods has been promoted with a view of encouraging the internal industry of the country, and the export of foreign produce, as a means of drawing wealth from other countries by the profits of the carrying trade. The excess of the value of goods exported, beyond that of the imports, has usually been considered as a criterion of the profits which a country derives from foreign trade; but this is a very fallacious mode of determining a point of great importance; advantageous foreign trade might long exist, even if the imports constantly exceeded the value of the exports. The laws in force relating to exportation, consist principally of prohibitory, or restrictive regulations respecting bullion, corn, wool, machinery, and tools used in various branches of manufactures, the exportation of which, it is thought, might diminish the necessary supply of provisions for the consumption of the country, or enable foreigners to rival valuable branches of its manufactures. The acts relative to the exportation of wool, prohibit the exportation, not only of the article itself, but also of live sheep, rams, or lambs, from Great Britain, Ireland, Jersey, Guernsey, Alderney, Sark, or Man, on penalty of the forfeiture thereof, and of the ships conveying the same; also 3*l.* for every sheep, &c. and the offender to suffer three months solitary imprisonment; for a second offence 5*l.* per sheep, &c. and six months imprisonment: except wether sheep for ships' use only, put on board by licence of the port officer of the customs. A limited quantity of wool is, however, permitted to be exported from the port of Southampton to Jersey, Guernsey, Alderney, and Sark. The duties on exportation, payable in Great Britain and Ireland, which were formerly the principal branch of the revenue derived from foreign trade, are now of small amount in comparison with the duties payable on goods brought into the country. See Customs.

EXPRESSED *oil*. See Oil.

EXPRESSION, in chemistry, or pharmacy, denotes the act of expressing out the juices or oils of vegetables, which is one of the three ways of obtaining them; the other two being by infusion and decoction. The hard fruits require to be well bruised previously to expression, but herbs are only to be moderately bruised. They are then to be included in a hair bag, and pressed between wooden plates in the common screw press, till the juice ceases to run. The expression of oils is performed nearly in the same manner as that of juices, only iron plates are to be used instead of wooden ones. The insipid oils of all unctuous seeds are obtained uninjured by this operation, if performed without the aid of heat, which though it promotes the extraction of the oil, gives it an ungrateful flavour. The oils expressed from aromatic substances, generally carry with them a portion of their essential oil. Hence the smell and flavour of the expressed oils of nutmegs and mace.

Expression, in rhetoric, the elocution, diction, or choice of words in a discourse. Beautiful expression is the natural and true light of our thoughts: it is to this we owe all the excellencies in discourse, which gives a kind of vocal life and spirit. As the principal end of discourse is to be understood, the first thing we should endeavour to obtain is a richness of expression, or habit of speaking so well as to make our thoughts easily understood.

Expression, in painting, a natural and lively representation of the subject, or of the several objects intended to be shewn. The expression consists chiefly in representing the human body and all its parts, in the action suitable to it: in exhibiting in the face the several passions proper to the figures, and observing the motions they impress on the external parts. See Painting.

EXSICCATION, in pharmacy, the drying of moist bodies, for which two methods are usually employed, in one the humid

parts are exhaled by heat, in the other they are imbibed or absorbed by substances, whose texture is adapted to the purpose. Bodies combined with, or dissolved in a fluid, require the first: such as are only superficially mixed with it, are separated by the second method. Vegetables are usually exsiccated by the natural warmth of the air, but the assistance of a gentle artificial heat is often found very useful. By a moderate fire the more tender flowers may be dried in a short time without any considerable loss, either of their odour or lively colour, which would be injured, or perhaps destroyed, by the more slow exsiccation in the air. Some plants, particularly those of the acrid kind, lose their virtues by that process.

EXTENSION, in philosophy, one of the common and essential properties of body, or that by which it possesses or takes up some part of universal space, which is called the place of that body.

Extension is divided, 1. either into length only, and then it is called a line; or, 2. Into length and breadth, which is called a superficies; or, 3. Into length, breadth, and depth, which is called a solid; being the three dimensions according to the quantity of which the magnitude or bulk of bodies are estimated. Extension, according to Mr. Locke, is space considered between the extremities of matter, which fills up its capacity with something solid, tangible, and moveable. Space, says that philosopher, may be conceived without the idea of extension, which belongs to body only.

EXTENSOR, an appellation given to several muscles, from their extending or stretching the parts to which they belong. See ANATOMY.

EXTENT, in law, a writ of execution or commission to the sheriff, of one who being bound by statute, has forfeited his bond, for the valueing of lands or tenements; sometimes the act of the sheriff upon this writ.

EXTERMINATION, in general, the extirpating or destroying something. In algebra, surds, fractions, and unknown quantities are exterminated by the rules for reducing equations. Thus to take away the fractional form from these equations $\frac{a}{b} = \frac{x}{y}$; and $\frac{a^2+b^2}{2c} = \frac{x}{y}$; in both cases we multiply the numerator of one fraction by the denominator of the other, and the equations become $ay = bx$ and $a^2y + b^2y = 2cx$: so again to take away the sign of the square, or cube, or other root, as $\sqrt[2]{a^2+y^2} = 4z$ we raise the $4z$ to the second power, and take off the sign of the root on the other side of the equation thus $a^2 + y^2 = 16z^2$: and when $n\sqrt{a+b} = x$: then $a + b = x^n$. To exterminate a quantity from any equation there are divers rules. See ALGEBRA.

We shall however give an instance in this place: thus to exterminate y out of these two equations

$$\begin{aligned} a + x &= b + y \\ 3b &= 2x + y \end{aligned}$$

subtract the upper equation from the under and there remains $3b - a - x = 2x - b$, hence $3x = 4b - a$ and $4 = 1\frac{b-a}{3}$.

Suppose also two equations given involving two unknown quantities, as

$$\left\{\begin{aligned} ax + by &= c \\ dx + ey &= f \end{aligned}\right\} \text{ then shall } y = \frac{af - dc}{ae - db}.$$

Where the numerator is the difference of the products of the opposite coefficients, in the orders in which y is not found; and the denominator is the difference of the products of the opposite coefficients, taken from the orders that involve the unknown quantities. For from the first equation it appears that $ax = c - by$, and $x = \frac{c - by}{a}$; and from the second equation, that $dx = f - ey$, and $x = \frac{f - ey}{d}$. Therefore, $\frac{c - by}{a} = \frac{f - ey}{d}$; and $cd - dby = af - aey$, whence $aey - dby = af - cd$; and $y = \frac{af - cd}{ae - db}$.

To exemplify this theorem, suppose $a = 5$, $b = 7$, $c = 100$, $d = 3$, $e = 8$, and $f = 80$. Then $y = \frac{\overline{5 \times 80} - \overline{3 \times 100}}{5 \times 8 - 3 \times 7} = \frac{100}{19} = 5\frac{5}{19}$; and $x = \frac{240}{19} = 12\frac{12}{19}$.

If three or four equations are given, involving three or four unknown quantities, their values may be found much in the same manner.

EXTERNAL *medicines*, the same with local or topical medicines.

EXTERNAL *angles*, are the angles on the outside of any right-lined figure, when all the sides are severally produced, and they are all, taken together, equal to four right angles.

EXTINGUISHMENT, in law, where-

ever a right, title, or interest is destroyed, or taken away by the act of God, operation of law, or act of the party, it is called an extinguishment; a creditor's accepting a higher security than he had before is an extinguishment of the first debt.

EXTORTION, in law, any oppression by colour or pretence of right.

EXTRA *judicial*, in law, is when judgment is given in a cause or case not depending in that court, where such judgment is given, or wherein the judge has no jurisdiction.

EXTRA *parochial*, out of any parish; privileged or exempted from the duties of a parish.

EXTRACT, in pharmacy, the soluble parts of vegetable substances, first dissolved in spirit or water, and then reduced to the consistence of a thick syrup, or paste, by evaporation. See PHARMACY.

EXTRACTION, in chemistry, is the general operation by means of which we separate and extract from very compounded bodies of the vegetable and animal kingdoms, different matters contained in them. For this purpose alcohol, water, acids, and alkalies are made use of. Therefore extraction is performed by dissolutions, macerations, infusions, &c.

EXTRACTION, in surgery, is the drawing any foreign matter out of the body by the hand, or by the help of instruments.

EXTRACTION, in genealogy, implies the stock or family from which a person is descended.

EXTRACTION *of roots*, in algebra and arithmetic, the method of finding the root of any power or number. See ALGEBRA.

EXTRACTOR, in midwifery, an instrument, or forceps, for extracting children by the head. See MIDWIFERY.

EXTRAVASATION, in contusions, fissures, depressions, fractures, and other accidents of the cranium, is when one or more of the blood-vessels that are distributed on the dura mater, is broke or divided, whereby there is such a discharge of blood as greatly oppresses the brain, and disturbs its offices; frequently bringing on violent pains, and other mischiefs; and, at length, death itself, unless the patient is timely relieved.

EXTREME *and mean proportion*, in geometry, is when a line is so divided into two parts, that the rectangle under the whole line, and the lesser segment, is equal to the square of the greater segment.

EXUVIÆ, among naturalists, denote the cast-off parts or coverings of animals, as the skins of serpents, caterpillars, and other insects. See ENTOMOLOGY.

M. Reaumur is very particular in describing the manner in which the caterpillar tribe throw off, or extricate themselves from their exuviæ. See vol. i. of the "History of Insects."

The crab, as is well known, can even throw off its limbs at pleasure, which are again replaced by new ones. See CANCER.

EXUVIÆ is also used for the remains of sea animals, found fossile, and more properly called extraneous, or marine fossils.

EYE. See ANATOMY and OPTICS.

EYE, in architecture, is used to signify any round window made in a pediment, an attic, the reins of a vault, or the like.

EYE *of a dome*, an aperture at the top of a dome, as that of the Pantheon at Rome, or of St. Paul's at London: it is usually covered with a lantern.

EYE, in agriculture and gardening, signifies a little bud, or shoot, inserted into a tree, by way of graft.

EYE *of a tree*, a small pointed knot to which the leaves stick, and from which the shoots or sprigs proceed.

EYE-*bright*. See EUPHRASIA.

F.

F, the sixth letter of the alphabet, and fourth consonant, is by some reckoned a mute, and by others a semi-vowel: it is formed by forcing the breath out strongly, and at the same time joining the upper teeth and under lip: it has much the same sound with the Greek φ, or *ph* in English words, and is only written in words of Latin origin, *ph* being used instead of it in those derived from the Greek. Suetonius tells us, that the emperor Claudius invented the *f*, and two other letters; and that it had the force

of *v* consonant, and was wrote inverted Ⅎ.

As a numeral, F denotes 40, and with a dash over it thus $\overline{F}$, 40,000: in music, it stands for the bass clef; and frequently for *forte*, as *ff* does for *forte forte*.

As an abbreviation, F stands for *filius*, *fellow*, and the like: thus F. R. S. signifies Fellow of the Royal Society.

FA, in music, one of the syllables invented by Guido Aretine, to mark the fourth note of the modern scale, which rises thus, *ut*, *re*, *mi*, *fa*.

Musicians distinguish two *fa*'s, *viz.* the flat, marked with a ♭, or ♭; and the sharp or natural, marked thus ♮, and called biquadro.

FABER, a fish of the zeus kind, called in English doree, or john doree. See Zeus.

FABLE is used for the plot of an epic or dramatic poem, and is, according to Aristotle, the principal part, and, as it were, the soul of a poem.

FABRICIA, in botany, a genus of the Icosandria Monogynia class and order. Calyx five-cleft, half superior; five petals, without claws; stigma capitate; capsule many-celled; seeds winged. There are two species; *viz.* the myrtifolia and the lævigata, both found in New Holland.

FACE, comprehends all that part of the head which is not covered with the common long hair. See Anatomy.

Face, or *facade*, in architecture, the front of a building, or the side which contains the chief entrance. Sometimes, however, it is used for whatever side presents to the street, garden, court, &c. or is opposite to the eye.

Face, in fortification, an appellation given to several parts of a fortress, as the face of a bastion, &c.

FACET, or Facette, among jewellers, the name of the little faces or planes to be found in brilliant and rose diamonds.

FACTITIOUS, any thing made by art, in opposition to what is the produce of nature. Thus, factitious cinnabar is opposed to native cinnabar. See Cinnabar.

FACTOR, in commerce, is an agent or correspondent residing beyond the seas, or in some remote part, commissioned by merchants to buy or sell goods on their account, or assist them in carrying on their trade.

A factor, in law and in merchandise, is one authorized to sell goods and merchandise, and otherwise act for his principal, with an allowance or commission for his care. He must pursue his orders strictly. He is accountable for all lawful goods coming to his hands; yet if the factor buy goods for his principal, and they receive damage in his possession, through no negligence of his, the principal shall bear the loss; and if a factor is robbed, he shall be discharged: if a factor act contrary to his orders in selling goods, he is liable for the loss, though there may be a probability of advantage by his act: so he is liable for not making insurance, if ordered to do so.

Factor, in multiplication, a name given to the multiplier and multiplicand, because they constitute the product. See Arithmetic.

FACTORAGE, called also commission, is the allowance given to factors by the merchant who employs them.

FACTORY is a place where a considerable number of factors reside, to negotiate for their masters and employers. The most considerable factories belonging to the British are those established in the East Indies. There were also factories in Portugal, Turkey, and at Hamburgh, Petersburgh, Dantzic, and Amsterdam, all endowed with certain privileges. The ascendency of the French Emperor, for the present, at least, has put an end to these, or to the most of them. We trust, however, that a change of circumstances may hereafter place things on their old footing.

FACULÆ, in astronomy, certain bright and shining parts, which the modern astronomers have, by means of telescopes, observed upon or about the surface of the sun; they are but very seldom seen. One was seen by Hevelius in 1634, whose breadth was said to be equal to a third part of the sun's diameter.

FACULTY, in law, a privilege granted to a person, by favour and indulgence, of doing what, by law, he ought not to do. For granting these privileges, there is a court under the Archbishop of Canterbury, called the court of the faculties, the chief officer whereof is styled master of the faculties, who has a power of granting dispensations in divers cases, as to marry without the bans being first published; to eat flesh on days prohibited; to ordain a deacon under age; for a son to succeed his father in his benefice; a clerk to hold two or more livings, &c.

Faculty, in the schools, a term applied to the different members of an university, divided according to the arts and sciences taught there: thus in most universities there

are four faculties, *viz.* 1. Of arts, which include humanity and philosophy. 2. Of theology. 3. Of physic. And, 4. Of civil law. The degrees in the several faculties of our universities are those of batchelor, master, and doctor.

FACULTY *of advocates*, a term applied to the college or society of advocates in Scotland, who plead in all actions before the Court of Session. They meet in the beginning of every year, and choose the annual officers of the society, *viz.* dean, treasurer, clerks, private and public examinators, and a curator of the library.

FÆCULA, in chemistry, the substance obtained by bruising or grinding certain vegetables, or grain, in water; the fæcula is that part which after standing some time falls to the bottom; this, in plants, appears to be only a slight alteration of their mucilage, for it differs from mucilage in no other respect than in being insoluble in cold water. Most plants contain fæcula, but the seeds of gramineous and leguminous vegetables, and all tuberose roots contain it in great abundance.

FAGARA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Dumosæ. Terebintaceæ, Jussieu. Essential character: calyx four-cleft; corolla four-petalled; capsule two-valved, with one seed. There are ten species.

FAGONIA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Gruinales. Rutaceæ, Jussieu. Essential character: calyx five-leaved; petals five, cordate; capsule five-celled, ten-valved, with one seed in each cell. There are three species.

FAGRÆA, in botany, so called in honour of Jonas Theodor Fagræus, M. D. a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: calyx bell-shaped; corolla funnel-shaped; berry two-celled, fleshy; seeds globular; stigma peltate. Only one species.

FAGUS, in botany, *chesnut tree,* a genus of the Monoecia Polyandria class and order. Natural order of Amentaceæ. Essential character: male, calyx five-cleft, bell-shaped; corolla none; stamina twelve: female, calyx four-toothed; corolla none; styles three; capsule muricate, four-valved; seeds two. There are five species, *viz.* two chesnut trees, and three of the beech, one of which is a native of Cochinchina.

FAINT *action*, or FEIGNED *action*, in law, is a sort of fictitious suit, contrived for the purpose of trying a particular question of fact, and is generally directed by the Court of Chancery.

FAIR, a greater kind of market, granted to a town, by privilege, for the more speedy and commodious providing of such things as the place stands in need of. It is incident to a fair, that persons shall be free from being arrested in it for any other debt contracted than what was contracted in the same; or, at least, promised to be paid there. These fairs are generally kept once or twice a year, and, by statute, they shall not be held longer than they ought, by the lords thereof, on pain of their being seized into the King's hands, &c. Also proclamation is to be made how long they are to continue; and no person shall sell any goods after the time of the fair is ended, on forfeiture of double the value, one fourth to the prosecutor, and the rest to the King. There is a toll usually paid in fairs, on the sale of things, and for stallage, picage, &c.

FAIRS and MARKETS, in law. No person can claim a fair or market, unless by grant from the King, or by prescription, which supposes such grant. Owners and governors of fairs are to take care that every thing be sold according to just weight and measure, and for that and other purposes may appoint a clerk of the fair or market, who is to mark and allow such weights, and for his duty can only take his reasonable and just fees.

Generally, all regular sales of things usually sold there shall be good, not only between the parties, but also binding on all those that have any right or property therein.

FAIRY *rings*. The circles of dark-green grass frequently observed in old pastures, have long been known under the name of fairy rings, and have generally been supposed to be occasioned, in some way or other, by electricity. Dr. Wollaston has, in a late volume of the "Transactions of the Royal Society," given a new and very ingenious theory, of which we shall present our readers with a brief account, premising that Mr. Davy, in the course of his lectures at the Royal Institution, had occasion to refer to the subject, and seemed to coincide in opinion with Dr. Wollaston. That which first attracted his notice was the position of certain fungi which are always found growing upon these circles, if examined in a

proper season. The position of these fungi led him to imagine that the progressive increase from a central point was the probable mode of formation of the ring: hence he conjectured that the soil, which had once contributed to the support of the fungi, might be so exhausted of some peculiar pabulum necessary for their production as to be rendered incapable of producing a second crop. The second years crop would, if this theory be just, appear in a small ring surrounding the original centre of vegetation, and at every succeeding year the defect of nutriment on one side would necessarily cause the new roots to extend themselves solely in the opposite direction, and would occasion the circle of fungi continually to proceed, by an annual enlargement, from the centre outwards. An appearance of luxuriance of the grass would follow as a natural consequence, as the soil of an interior circle would always be enriched by the decayed roots of fungi of the year's growth. This theory is supported by some observations of Dr. Withering; and Dr. Wollaston says, by way of confirmation, that whenever two adjacent circles are found to interfere, they not only do not cross each other, but both circles are invariably obliterated between the points of contact: the exhaustion occasioned by each obstructs the progress of the other, and both are starved. Phil. Trans. 1807, Part II.

Though it cannot be doubted that most fairy rings, if not all of them, have considerable relation to the running of a fungus; there, nevertheless, seems reason to conclude that electricity may likewise be concerned in their production. The electrical effect may relate to fairy rings of a different kind from those occasioned by the fungus, or it may have been antecedent to the production of the vegetable. It is a familiar effect in our experiments that the spark proceeding from a positive conductor breaks or radiates at about one third of its course, and strikes the receiving conductor by a central spark surrounded by other smaller ones. The concentric rings produced upon polished metallic surfaces by the strong explosion of a battery, as first observed by Priestley, appears to be a fact of the same kind; and the forked radiations of lightning are well known. The editor of this work related in the Phil. Journal, Vol. I, 4to. some events which happened in Kensington Gardens in June, 1781, when a very powerful thunder storm passed over the western extremity of London. The explosions were very marked and distinct, and in many instances forked at the lower end, but never at the top; from which it seems proper to conclude that the general mass of clouds, or, at least, that extremity which passed over London, was in the state called positive.

Five days afterwards, upon visiting Kensington Gardens, it was observed, that every part of that extensive piece of ground shewed marks of the agency of the lightning, chiefly by discolouration of the grass in zigzag streaks, some of which were 50 or 60 yards in length. Instances of this superficial course of the lightning, along the ground, before it enters the earth, are sufficiently frequent. But the circumstance applicable to our present subject is, that five trees, out of a grove consisting of seven, had been struck by the lightning. Two of them, which stood on the outside to the westward, had holes torn in the ground, close to the trunk; and round one of these trees was a space of six feet in diameter, in which the grass was very much scorched. Another tree on the west was surrounded by a faint ring of burnt or faded grass, which seemed to be occasioned by some earlier stroke, as the vegetation had began to shoot up again. Another tree, standing on the outside to the south, was surrounded by a ring of 12 feet diameter and 18 inches broad. Within the ring the grass was fresh; but on the surface of the ring, the grass and the ground were much burned. To the eastward of the tree, upon the ring itself, were two holes, in which the ground had the appearance of ashes. Another tree, on the east-side of the grove, had the half of a faint ring to the westward. And, lastly, a tree which stood in the middle was surrounded by a faint ring of 12 feet diameter, within which the grass was unhurt; and to the westward, at the distance of about three feet from the inner ring, was part of another similar ring, of nearly the same appearance; the verdure being unhurt in the interval between the rings.

FALCO, the *falcon*, in natural history, a genus of birds of the order Accipitres. Generic character: the bill hooked and covered at the base with a cere; head and neck covered with closely-set feathers; tongue bifid at the end; nostrils placed in the cere; legs and feet scaly; middle toe connected with the outermost by a strong membrane as far as the first joint; claws large, much hooked, and very sharp; the

female stronger and larger than the male. The falcon tribe uniformly have close-set feathers on the head and neck, and, in this respect, are particularly distinguished from the vulture tribe, which are destitute of feathers always on part of the head, and sometimes on the whole head and neck. The claws of the falcon class are more hooked and sharp also than those of the vulture. The falcon derives exquisite delight from destroying its prey, and devouring it while fresh. Though it will sometimes devour a quantity of food calculated to excite astonishment, at one repast, it will endure abstinence of several days' duration, and has been even stated by some to survive in situations in which, for weeks, it has not had the smallest supply. It lives on fish, as well as on flesh, and also on snakes and reptiles. It is confined to no particular climate, but found in almost all. To the falcon class belongs the eagle, which takes the precedence among birds, as the lion among quadrupeds, from its strength, activity, and courage; and some ingenious naturalists have been fond of running a parallel between these animals, to a considerable extent and minuteness. It is observed of the eagle, that he never undertakes a chase singly, but when the female is engaged in incubation, or in feeding her young; during this period he supplies, by his solitary exertions, the wants of his partner and of himself; at every other season their efforts are united in the pursuit of prey. They often soar beyond the reach of the human eye; but, though unseen, their sounds are heard with considerable distinctness, and have been compared to the barking of a dog.

There belong to the falcon genus, according to Latham, 98 species, and Gmelin enumerates no fewer than 136. The following merit the principal attention.

F. chryasætus, or the golden eagle, measures more than three feet in length, and above eight in breadth, and weighs about 16 pounds; the male weighs little more than two-thirds of the female. This bird has been known to breed in the highest mountains of Wales, and among the Cheviot hills, but is very rarely indeed recognized in Great Britain, though it is said to be seen not unfrequently in the mountainous districts of the sister island: it is very seldom found beyond the 55th degree of northern latitude. See Aves, Plate VII. fig. 1.

The F. leucocephalus, or the bald eagle, is found in Europe, but more frequently in North America, and lives on fish as well as flesh. The singular manner in which it procures the former is deserving of notice: fixing on some convenient situation, open to the water, it watches with its intensely observant eye the movements of the osprey; when it perceives this bird bearing off a fish in its mouth, the eagle quits its station, and pursues it with the swiftness of a meteor; the fish is instantly dropped from the mouth of the osprey, and, in its fall, intercepted by the eagle with the most energetic and successful dexterity.

F. ossifragus, or sea-eagle, frequents the sea-shore, and subsists principally upon fish; it is nearly of the size of the golden eagle, and is found in many countries both of Europe and America; its sight is stated to be equally clear by night and by day. Mr. Barlow relates, that he saw a bird of this species engaged once in a violent conflict in the air with a cat which he had lifted in his talons, whose efforts, however, were finally too powerful for him, and brought him again to the ground.

F. haliaetus, or the osprey, is to be found in almost all parts of Europe, on the borders of lakes and rivers, which it frequents for the sake of the fish contained in them, which constitute its principal subsistence, and on which it darts with unerring accuracy; it builds on the ground among reeds, and is the most numerous of the larger birds of prey. See Aves, Plate VII. fig. 3.

F. buteo, or the common buzzard. The buzzard is abundantly provided with means of defence, as well as attack; but is sluggish and cowardly with all its strength, and will suffer itself to be brought to the ground by a sparrow-hawk, without at all employing those means, which, if fully exerted, would uniformly and inevitably prove fatal to the assailant. The length of the common buzzard is about 20 inches; scarcely any two of the species are marked alike; its food consists of birds, vermin, reptiles, and insects. If the female bird be destroyed by violence or disease during incubation, the male will, it is said, succeed to the charge, and perfectly accomplish it.

F. milvus, or the kite, is about two feet long, and distinguished from the buzzard by a forked tail. In England it continues during the whole year; in various parts of Europe it is migratory, and, as winter approaches, takes its flight to Egypt. It preys chiefly upon small birds, and, from a distance in the air at which it is invisible to

the sight of man, will pounce on them with incredible rapidity and fatal precision. It frequently makes attempts and depredation on broods of young chickens, and furnishes hereby to the observer an interesting spectacle of maternal affection and courage in the hen: from these conflicts the kite generally retires worsted, and obliged to await the opportunity when he may elude the almost incessant vigilance of the dam, or pick up an unfortunate straggler beyond the reach of her superintendance.

F. palumbarius, or the goshawk, is about twenty inches in length; it feeds on mice and small birds, which last it plucks, before it devours them, with great dexterity and neatness; it tears these and other animals to pieces before eating them, then swallows these pieces whole, and throws up from its stomach the hair or remaining feathers which belonged to them, in the form of small pellets. This bird was formerly in high estimation in this country when the diversion of falconry prevailed, and was trained by very careful discipline to the most accurate obedience of its keeper, and to the most vigorous and fatal pursuit of numerous animals, which, in a state of nature, it left unmolested: even geese and cranes, and also rabbits, it was taught to consider as its prey, and by the judicious application of rewards and punishments, its natural powers attained an improvement which previously would scarcely have been deemed possible, from any efforts for this purpose. So difficult was it, however, to meet with that coincidence of circumstances, necessary to produce this great discrimination, tractability, courage, and obedience, that the price of a well-trained cast of these birds was extremely high, and is recorded, in one instance, to have been no less than the immense sum, in those days, of a thousand pounds. The ladies partook in this interesting sport with the keenest relish, notwithstanding its fatigues and dangers. The cultivation of this island has long been so far improved as to preclude the continuance of this diversion, which requires for its purpose a large tract of uninclosed country; in some parts of Europe it is still in use; in China it is practised, occasionally, for the Emperor's amusement, and conducted with all the form and splendour characteristic of Oriental manners. In England the goshawk is to be seen very rarely; in Scotland it is comparatively frequent; in France and Germany, in Siberia and North America, it is far from uncommon.

Various other species of the falcon were in use formerly for the diversion above noticed, especially the jer-falcon, and the kestrel, belonging to the class of the long-winged hawks, and the sparrow-hawk, which belonged to the short-winged class, a class less active and rapid than the former. The sparrow-hawk is the terror of pigeons, partridges, and poultry, and commits its depredations with the most astonishing boldness. The male weighs only five ounces, and the female nine, presenting the strongest known case of this sexual difference.

For the stone-falcon, see Plate VII. fig. 2.

FALCONRY, the art of training all manner of hawks, but more especially the larger sort, called falcons, to the exercise of hawking.

FALKIA, in botany, so called in honour of J. P. Falck, professor at Petersburgh, a genus of the Pentandria Digynia class and order. Natural order of Campanaceæ. Borragineæ, Jussieu. Essential character: calyx bell shaped, five-cleft; corolla bell shaped; stigmas orbicular peltate; seeds four-arilled. There is but one species, *viz.* F. repens, creeping Falkia.

FALL, in the sea-language, that part of the rope of a tackle, which is hauled upon. Also when a ship is under sail, and keeps not so near the wind as she should do, they say she falls off; or when a ship is not flush, but hath risings of some parts of her decks more than others, it is called falls.

FALLING-STAR, in meteorology, a phenomenon that is frequently seen, and which has been usually supposed to depend on the electric fluid. Mr. Davy, in a lecture delivered a few weeks since at the Royal Institution, gave many reasons against this opinion: he conceives that they are rather to be attributed to falling stones. It is observable that when their appearance is frequent they have all the same direction; and it has been remarked that they are the forerunners of a westerly wind in our country.

FALLOPIAN *tubes*, two canals of a tortuous figure, but approaching to a conic form, joined to the fundus of the uterus, one on each side. See ANATOMY.

FALLOWING, in agriculture, the practice of preparing lands by repeated ploughing, harrowing, &c. so as to render them fit for the growth of grain. Though by the frequent turning of land and exposing

new surfaces of the soil to the operation and influence of the atmosphere, various changes are effected in the earthy particles, yet one great purpose in fallowing, is to destroy more effectually the weeds, which, in consequence of previous mismanagement, and of over-cropping, have increased to such a degree as to render cultivation for grain no longer profitable. Land being allowed to rest for a season from yielding a crop, and being repeatedly ploughed, the soil exposed to the influence of the different seasons, and at the same time completely pulverized, its fertility is again somewhat restored, so that, by the application of a smaller portion of manure than would be otherwise necessary, it is rendered fit for again producing valuable crops of grain or grass. It is universally acknowledged, that all soils, even those naturally the most fertile, are capable of being rendered unproductive by constant and severe cropping, and that the more improper the modes of cropping are, the sooner, and the more certainly, will a comparative barrenness ensue. Hence the propriety of fallowing, where imperfect modes of culture are adopted. Fallowing, in what may be called the infancy of improvements in agriculture, is also essentially necessary. If land be greatly exhausted, no matter by what sort of previous mismanagement, fallowing is the most expeditious, the most effectual, and, every thing considered, the least expensive method that can be adopted for restoring its fertility, and rendering it productive. It is the most expeditious, because it is completely done in the course of one season; whereas several years of culture, and a great additional quantity of manure, would be requisite, were any other less effectual mode of tillage adopted. It is the most effectual, because the farmer has it in his power to destroy every weed, to turn over and expose the soil to the influence of the weather in the different seasons, and also to level and straighten the ridges, drain the land, and remove every obstruction to the introduction of better modes of husbandry, none of which could be so conveniently or effectually performed between the harvest of one year and the seed-time of the next. Fallowing is also the least expensive method by which the fertility of land greatly exhausted can be restored, and the only one that can be adopted with a certainty of success, for the removal of every obstacle to the introduction of more perfect agriculture. Manure operates more powerfully when applied to a field that has been properly summer-fallowed than when laid on one that has been long under an improper course of cropping. The returns, after fallowing, will be to a certainty greater; and, therefore, although the actual expense of fallowing is considerable, yet the crop that succeeds is so much greater as to counterbalance that expense, while those that follow, if properly adapted to the soil, will yield the farmer a proper compensation for his extra trouble and expense. Such is the opinion of Mr. Donaldson, to which Mr. A. Young does not assent; he thinks every advantage is to be attained by judicious cropping. See Agriculture.

FALSE *imprisonment*, in law. To constitute the injury of false imprisonment, two points are necessary: the detention of the person, and the unlawfulness of such detention. Every confinement of the person is imprisonment, whether in a common prison, or a private house, or even by forcibly detaining one in the streets.

FALX, in anatomy, a process of the dura mater placed between the two hemispheres of the brain, and resembling a reaper's sickle.

FAMES *canina*, an excessive appetite. See Bulimy.

FAMILY, denotes the persons that live together in one house, under the direction of one head or chief manager. It also signifies the kindred or lineage of a person, and is used by old writers for a hide or portion of land sufficient to maintain one family.

Family, in natural history, a term used by authors to express any order of animals, or other natural productions of the same class.

FAN, an instrument used in winnowing corn.

FARINA, a term given to the pulverulent and glutinous part of wheat and other seeds, obtained by grinding and dressing. See Fæcula.

Farina *fœcundans*, among botanists, the impregnating meal or dust on the apices or antheræ of flowers, which, being received into the pistil or seed-vessel of plants, fecundates the rudiments of the seeds in the ovary, which otherwise would decay and come to nothing. The manner of obtaining the farina of plants for microscopical observation is this: gather the flowers in the midst of a dry sun-shiny day, when the dew is perfectly off; then gently

shake off the farina, or lightly brush it off with a soft hair-pencil, upon a piece of white paper; then take a single talc of isinglass between the nippers, and, breathing on it, apply it instantly to the farina, and the moisture of the breath will make that light powder stick to it. If too great a quantity is found adhering to the talc, blow a little of it off; and if there is too little, breathe upon it again, and take up more. When this is done, put the talc into the hole of a slider, and applying it to the microscope, see whether the little grains are laid as you desire, and if they are, cover them up with another talc, and fix the ring; but care must be taken that the talcs do not press upon the farina in such a manner as to alter the form.

FARM. See AGRICULTURE.

FARRIER, is the designation of the smith who devotes his attention chiefly to shoeing horses, and to curing them of all kinds of diseases. Perhaps it would be difficult to quote any profession which could competite with this in self-sufficiency and ignorance; nor would it be easy to estimate the damage done by this tribe, who, having a technical jargon peculiarly appropriated to their presumptuous quackery, continue to deceive a large portion of the community, and generally hold a very improper intercourse with grooms, &c. whence not only expensive jobs are unnecessarily created, but the constitutions of the unfortunate animals which are committed to their care, are often very seriously injured. We trust that what we shall state relating to the succeeding article, will contribute to remove the deception, and to enable every person to form some judgment of the ailings to which horses are subject. The term farrier is derived from the French word *ferriere*, which relates particularly to the bag of implements used by the *marechal*, or person who confines his operations to this branch of smithery.

FARRIERY, as may be seen in the preceding article, originally implied nothing more than the art of applying iron, or other substances, to the feet of horses, whereby to defend them from the injuries to which they are subject in travelling on hard surfaces. It was probably owing to the opportunities afforded to the smiths, while shoeing horses, of observing the various diseases of the foot, and consequently of haranguing on the subject, that they, in time, acquired an undue reputation for perfect ability in not only that particular, but for a general knowledge of whatever related to the animal at large. It will not surprise us to find persons so ignorant, as our forefathers of yore were, yielding thus implicitly to the presumptuous claims of the farrier; indeed, when we consider how little was known of the art of medicine, and of the very structure of the human frame, it must appear that no other alternative presented itself. But we cannot look back to later dates without feeling both astonished and ashamed at the indifference, indeed the inhumanity, with which that most useful animal, the horse, has been so long treated.

Happily, however, in these days of improvement, when science has in so many instances removed the mists which clouded the vision of our ancestors, and has proportionally enlarged our ideas, the eye of research has been turned towards the sufferings of the brute creation, and a new profession has sprung up, which not only adds to our stock of medical information, but, while it removes that imputation of cruelty, which had too long stained the character of an enlightened age, promises to reward our kindness and assiduity, with the most liberal remuneration. In this we allude to the establishment of a Veterinary College, where, under the auspices of the most distinguished and public-spirited characters, the whole art of medicine and of surgery, so far as they relate to horses, &c. together with the true principles of shoeing, and of treating horses while in a state of disease and of health, are publicly taught by a surgeon, who has made them his study, and who has the designation of Professor of the Veterinary Art.

Such an establishment, which was not novel on the Continent, was truly a desideratum; like most of our important improvements, it was first proposed and acted upon by a foreigner, Monsieur St. Bel, who, in the year 1788, came over from France, and observing the lamentable want of veterinary knowledge, published proposals for the establishment of a college. The matter was not, however, noticed until the Agricultural Society of Odiham, in Hants, seeing the vast benefit which must inevitably result from such an institution, agreed to support Monsieur St. Bel. He was accordingly nominated to the professorship, under the patronage of many eminent characters. The Duke of Northumberland was elected president; and the list of vice-presidents was graced with the names of Earls Grosvenor, Morton, Oxford, and Rivers, Sir

George Baker, Sir T. C. Bunbury, Sir William Fordyce, and the celebrated John Hunter, Esq.

Vicinity to London being an important object, and a pure air no less indispensable, Pancras was fixed upon for the scite of the college. Its success, however, was not, in the first instance, much to be vaunted; indeed its stability became somewhat doubtful, owing to a variety of causes. The fact seems to be, that St. Bel, though a perfect enthusiast, and to a certain degree skilled in the veterinary art, had not that complete acquaintance with the subject which so conspicuous a situation imperiously demanded: he was also deficient in that peculiar ductility of disposition, and that accommodation to the opinions of others, which in every instance are prepossessing, and to a man in his situation were indispensable. He died in 1793, and Messrs. Coleman and Morecroft were appointed joint professors. Both these gentlemen appear to have been highly qualified for the pre-eminent situations they held: Mr. Coleman being a surgeon who had distinguished himself by a work of great merit, and Mr. Morecroft being a medical gentleman who had visited the continent, for the purpose of acquiring as complete an insight into veterinary operations as the schools in that quarter could furnish. The latter, however, ultimately retired, and left Mr. Coleman to fill the professor's chair, which he does with infinite advantage to the public, and with no less credit to himself.

A sum is allowed annually by Parliament towards the support of the college, which also derives some aid from the fees of students, and from subscription. The donation of twenty guineas makes a subscriber for life, and the payment of two guineas yearly gives the same title for that term. In either case the privilege of sending two horses to the veterinary hospital, free of all charges, except for keep, is thus acquired. His Majesty has given considerable importance to the institution, by requiring that all veterinary surgeons, employed in the army, should have passed examination at the college, and he has eminently served the whole of the cavalry corps by conferring on those surgeons the rank of commissioned officers. The various lecturers on medicine and surgery, who have so handsomely contributed their efforts towards the success of this important establishment, have on all occasions vied in promoting its welfare, and in extending its influence; by allowing the students to attend at their respective lectures, free of expense, those liberal professors have essentially served the institution.

We shall now endeavour to lay before our readers a concise account of the present improved mode of shoeing, and of treating diseases, as practised at the college.

The first object which comes under notice is the mechanical operation of shoeing. It would be entering on too extensive a field, were we to enumerate the various forms that have been recommended, together with the reasons assigned for the supposed superiority of each: we must content ourselves with describing the method now in use.

Mr. Coleman has the shoes made three times as thick at the toe as at the heels, because they wear more forward than behind. By this means the heels are less oppressed with weight, and the frog is allowed to come down to the ground: a matter of extreme importance. The nails are all placed forward, four on each side, but not approaching too near the heels, that they may not obstruct the elastic powers of those parts. The old method of fullering, *i. e.* making a groove in the shoe, being found injurious, by often breaking away the heads of the nails, they are now counter-sunk in conical or wedge-shaped holes, so that they may be driven up close to their thickest parts, and be out of the way of accident. By this means the nails and shoes appear as one body, and always wear together.

For horses which go in shafts, or are used in hunting, it is usual to make shoes with only one heel, which should be outward. The horse's heel must be rather lowered on that side, and the inner heel of the shoe somewhat thickened so as to balance, and bear equally. By this easy precaution a good footing is obtained, and cutting is effectually prevented. The best breadth for the shoe of a medium sized horse is said to be one inch at the toe, and three quarters at the heel; the weight about eighteen or twenty ounces. Light saddle-horses should not have shoes exceeding sixteen ounces; and, unless local circumstances prevail, twelve ounces will be generally found preferable.

In order to fit the shoe without causing the horse to stand too much on his heels, the under part of the crust, or wall of the hoof, is pared away to receive the excess of thickness in front; for the bottom of the shoe ought to be perfectly flat, without any stubs or calkings in front. Paring away the

heels is a most destructive practice, except in case of absolute excrescence in those parts; nor should the bars, (or diagonal ridges) that extend from the heels to the frog, or central projection, ever be cut more than is absolutely proper for the purpose of keeping them in a clean and healthy state. When it is considered how much the elastic power of the heels depends on the bars, which act as a spring between them and the frog, it must appear unreasonable that they should be shaved away, as is too often done by farriers, under the idea of preventing corns; though by such a process corns are created. A good open heel is the indication of a powerful foot; hence the sides of shoes ought not to be much contracted. When the heels are tender, what is called a bar-shoe, ought to be applied. By this simple contrivance, which saves them from pressure on uneven surfaces, many a horse has been found serviceable that must else have been condemned to the slaughter-house.

The frog appears to be the part on which the horse chiefly depends for a spring, or resistance, at the bottom of his foot. If this part does not touch the ground, the whole motion will be derived from the upper parts of the limb, and a very uneasy gait will inevitably follow. This points out the necessity for leaving it fully at liberty to come in contact with the ground. Some horses have been ruined by inattention to this point, and some few have naturally a defect in that part. To provide against such circumstances, Mr. Coleman uses an artificial frog, which receives the pressure, and gives the greatest firmness to the tread. It is usually but a temporary expedient, as the frog commonly grows and renders the substitute unnecessary.

Having given a general, but very correct outline of the process of shoeing, we shall proceed to a brief statement of the various diseases, &c. which usually come within the farrier's notice, in their alphabetical order.

Anarsarca, or dropsy of the skin, is generally called the water farcy, owing to the fluid being dispersed through the cellular membrane of the skin. It is known by pits remaining after the skin has been pressed by the finger; and, usually, proceeds from a deficiency of the absorbents, or an excess in the inhalents; from jaundice, hydatides, or previous inflammation. The cure is usually effected by stimulant applications, and by diuretics; smart friction, and gentle exercise, if long continued, are highly serviceable; the food should be nourishing. When only the lower extremities are diseased, rollers dipt in spirits, or in oil of turpentine, will generally remove the complaint. Horses are most subject to anasarca at spring and fall: when shedding their coats. If eruptions take place the cure is much facilitated: but they ought to be mildly treated, and suffered to heal voluntarily.

Ascites, or dropsy of the belly, may be known by the local swelling, which when gently struck undulates so as to be sensibly felt by the hand. This complaint arises from the causes just described, and occasions considerable thirst, short breath, and an obvious diminution of urinary discharge. To cure this complaint, every means should be used for strengthening, and accelerating, the secretion in general, and for promoting the circulation of the blood and fluids. Drastic purges, diuretics, sweating, and in some cases mercury, rarely fail to render important service. This disease, however, is apt to recur, unless the constitution be completely fortified, and the general habit brought into due state.

Bleeding, or blood-letting, should be performed with a lancet of a suitable size; the fleam being very uncertain on large rolling veins; and in the thigh, &c. absolutely dangerous: often producing violent inflammation, and sometimes incurable lameness. The jugular-vein is usually opened in common cases; especially when the head is the seat of disease: in other instances the plate-vein, or that within the thigh. In the first case a piece of thin cord should be passed round the horse's neck a little above the withers, and the part be wetted, so as to shew the vein. The quantity must depend on the case; but one or two quarts for periodical bleeding are enough to be drawn from a full-sized horse in good condition: in some cases much greater quantities must be taken. When the bleeding is to be stopped slacken the line, and pass a pin through the lips of the orifice; then taking a few hairs from the tail or mane, or a piece of thread, pass over the head and point of the pin therewith, in an alternate (i. e. a figure of 8) direction, and make fast.

Breaking down, as it is usually called, proceeds from a rupture of the suspensory ligaments, and chiefly happens to young horses in training. In this instance the fetlock nearly touches the ground, but the

foot can be bent when raised. Few cures are made, though much palliation may be effected, by reducing the inflammation in the first instance, raising the limb, especially the heel, so as to throw the weight on the other leg, and to relax the part. By this precaution, added to bleeding, purging, and the use of bracing applications, or eventually by firing, the limb may gradually become equal to very light exercise; but never can be depended upon, or be deemed sound.

Broken wind, this complaint is supposed to proceed from a rupture of the cells in the lungs: in the moment of the wind's being expelled from them, a check occurs which gives occasion to a second effort, thus causing a division in the sound: hence the term under which this complaint is known. The causes of this rupture are numerous, but the following are among the most frequent; viz. catarrhs, working after a full meal, or after drinking freely: girthing too tight: being suddenly put into hot stables after standing out in a cold air, &c. &c. This complaint, we believe, does not admit of a perfect cure; but, by much care, may be greatly relieved. The food should be compact and nutritious, such as corn and old hay. Carrots are excellent in this case, as are parsnips, and beet roots: probably on account of the saccharine matter they contain. We have heard, that molasses have been given in the water, (which should be in very small quantities,) with very great success. Some have used tar-water; others praise the effects of lime-water; but the greatest dependence should be placed on very sparing supplies of substantial food. The exercise ought to be regular, but never beyond a walking pace. If the symptomatic cough should prove troublesome, take away about three quarts of blood every third day.

Canker, is a sharp humour, called the thrush, which, in some instances, attacks the sole of the foot, and does inconceivable mischief: if neglected, it will in time, destroy the whole foot. The appearance of this complaint is decided; it rising like a fungous excrescence, covering the diseased part, and must be completely extirpated before a cure can be expected. Cut away freely from the horny sole, and dress the surface with a solution of lunar caustic dipped in tow. Fasten on well, as much depends on pressure: if the shoe be ribbed with cross bars, all the better. Raising the opposite foot, so as to make the horse bear on the cankered one, will facilitate the remedy.

Catarrh, often called morfoundering, is usually the effect of cold, and produces the same symptoms as among the human species. Sometimes acute fever attends; in such case the greatest service will be rendered by warm diluting drinks; or eventually by mild purges, aided by bleeding. Warm clothing, and a warm mash suspended in a nose-bag, will afford great relief. The glands should be covered with flannel, moistened in a mixture of hartshorn, one part, and olive oil, four parts. Avoid whatever is heating, and be careful to keep the bowels open, the skin moist, and the bedding abundantly supplied. The stable ought not to be kept too hot, as it would render the horse tender in his lungs, and perhaps induce to broken wind. Encourage the running at the nose: if obstructed the glanders would probably ensue.

Corns, consist of extravasated blood, or lymph, collected between the crust, or wall of the hoof, and the bars. These, in general, proceed from bad shoeing, especially from the heels being contracted, by hard labour, and improper pressure. Cut away as far as the extravasation, and apply a pledget of lint, dipped in tincture of myrrh, or in balsam of Peru. When the corn has been cut, the horse should be turned out to grass, without shoes, if practicable; or, if his labour cannot be dispensed with, let a chambered shoe be put on; so as to avoid pressing the part.

Cough, when this is symptomatic, it will disappear as the complaint which it attends may be removed; but if chronic, the cure will be uncertain, difficult, and tedious. The following cheap recipe has often proved serviceable. Tar eight pounds, lime twelve pounds, water six gallons; mix well, and give a quart every morning.

Cracks, in the heels, usually proceed from a gross habit, or from filth, or from washing the legs without rubbing them dry. Sometimes the cracks discharge a quantity of sharp ichor, which must be frequently removed, or severe excoriations may follow. Wash with strong soap-suds, lower the food, give mild purges, or diuretics, and, if the habit be full, bleed freely. Avoid all greasy applications, and allow no ligatures: wash often, and dry carefully.

Diabetes, or a profuse discharge of urine, is generally considered a fatal disease: it

is often brought on by violent medicines, especially diuretics, which should be carefully avoided in this complaint. Bad food is also a frequent cause. The surest remedy, if any can be so called, is to feed the horse with fresh blood, or with strong meat broth; avoiding vegetables, unless it be good wheaten bread. Opium, bark, chalk, and such tonics, and correcting medicines, as also the volatile liver of sulphur in small doses, will be usually found to give relief; though a perfect cure is scarcely to be expected.

Diarrhœa, or looseness, often follows the injudicious use of strong medicines; and especially where astringents have been given. The complaint is sometimes critical; in which instance it should not be checked, but treated with copious diluents of a soft kind. Sometimes hard labour, in bad weather especially, with bad stabling, or bad food, will induce this complaint, which is to be treated with great caution; lest it should degenerate into dysentery, inject the anodyne clyster, and give the following drink twice daily: opium two drachms, ipecacuanha three drachms, prepared chalk four ounces, thin starch a pint: mix, and drench with it. If it does not answer the intention within four days, at farthest, give alum whey, as recommended for the dysentery. Avoid all astringents, but give no cold drink, and encourage sweat by means of good clothing. Litter well, and allow a moderate current of air if the stable be hot.

Dysentery, or flux, commonly called molten-grease is a most painful and dangerous complaint. The animal is usually afflicted with tenesmus, and voids a great quantity of slimy mucus, and but little dung. This disease arises from a great variety of causes, and in some seasons is said to be epidemic.

The safest purge, in the first stage, is about a quart of castor oil. If that does not remove the fæces, give calomel four drachms, gum arabic two drachms, with honey enough to form a bolus. On all occasions ample clysters of gruel, linseed, water, &c. should be frequently injected. In obstinate cases administer the following: take ten poppy-heads, boil them in six quarts of water till only a gallon be left, add starch enough to soften into a thin mucilage, throw up three or four times daily. Internally the following may answer. Opium two drachms, ipecacuanha four drachms, nux vomica, in powder, one drachm, port wine one quart. Mix and repeat morning and evening. Let the horse be well clothed, so as to keep his skin moist; the stable should not be hot. If the dung smells offensively, the stable must be fumigated and kept extremely clean.

Farcy is easily removed in its first stage, when it consists of merely a superficial inflammation, but if suffered to proceed, it quickly taints the circulation, and often induces the glanders. It is highly infectious; in the first instance each bud or swelling, should be burnt with a hot iron, or by caustic; but when the blood is infected, (which is known by the buds being ulcerated, and a discharge at the nose,) the strongest medicines must be used. Let a scruple of corrosive sublimate, levigated, be mixt with butter, or in gruel, and given in two doses; *i. e.* night and morning. If the bowels should be affected, the dose must be less; but if no uneasiness be produced, it may be increased to half a drachm, or even to two scruples. If the sublimate should prove too powerful, substitute a drachm of calomel, night and morning. Green food is peculiarly serviceable. Destroy the clothing after a cure; or the disease will be regenerated.

Fever must always be traced to its cause, and its particular species must be ascertained before medicine is given. If the common inflammatory symptoms are indicated by the pulse, the eyes, and the general action of the horse, bleeding, to the extent of three or four quarts, according to size and condition, ought to be immediately practised: after this rake, and throw up the following clyster: gruel, or broth, 3 quarts; common salt (or Epsom salt, if at hand) 4 ounces; brown sugar, 4 ounces, and sweet oil, or melted butter, or lard, 4 ounces: administer blood warm, in a gentle manner. Give the following twice, daily: emetic tartar, 2 drachms; nitre, 1 ounce; mix in a pint of gruel, or form into a bolus with honey. Avoid whatever is heating; let the animal be kept in a cool stable (not windy or damp) and clothe moderately. Let him have plenty of warm drink of a diluent kind; such as bran-water, hay-tea, scalded malt, or warm ale; which last, ought, however, to be very mild. Leave a little very sweet hay for him to pick at: if at a proper season, green tares, or other young artificial grass may be given in small quantity. Avoid

tight girthing, and allow plenty of bedding. Sprinkle the stall occasionally with hot vinegar, and remove the dung as soon as it falls. If cold fits intervene, use warmer clothing, and let friction, with a soft brush, be persisted in, until warmth is restored. Above all things keep the body open, and avoid every thing that frightens or irritates: if the horse will lay down, it will favour the cure.

When a fever is symptomatic, the cause must first be removed; in the meanwhile soothing treatment should be resorted to, and palliatives be principally used. In this we allude to diet, &c. as detailed in the foregoing paragraph. When the fever runs very high, and that bleeding cannot be attempted (either at first, or in repetition) clysters must be frequently given, and rowels may be made in the breast and thighs.

When the fever is equivocal, or when it is decidedly of a malignant species, such as the typhus, or epidemic, which in some countries is by no means rare, though uncommon with us; if the horse be in a robust state, bleed copiously; but if emaciated, or of a weak frame, avoid that evacuation. Wash the body with warm vinegar, in which aromatic herbs have been boiled; sprinkle frequently with the same: remove the dung instantly, and change the bedding twice or thrice within the day. Burn nitre every half hour, so as to occasion a thick smoke, and let a piece of touch-paper be always smothering in a corner of the stable, which ought to be very cool. Keep the body open with antiseptic purges, and use little clothing. If a critical purging should come on, by no means check it; encourage every sore which may appear, and open rowels in various parts. This complaint being highly infectious, no other horse should be allowed to stand within the same area, in fact, horses labouring under the typhus fever, should be removed to some distance from other animals, whether horses, horned cattle, &c.; the infection being very apt to reach them.

Fistula being a complaint absolutely requiring the aid of a surgeon when in *ano, perineo*, &c. we refrain from stating any thing on that subject.

Fistulous withers will be found a very troublesome complaint; and under the hands of a common farrier, will seldom be cured without considerable delay, and great risk. We advise great cleanliness, and, that the part should be laid open, if the situation may admit; or, at all events, that a seton should be passed through the bottom of the sore, whence the matter might be discharged. Apply light pledgets of lint, just to keep the parts open; and when about to heal, which may be known by the granulations, &c. be cautious not to allow any pressure. If any of the dorsal spinous processes be tainted, exfoliation will take place: encourage the efforts of nature in that respect. Keep the body open, and let the diet be soft and cooling; allow free ventilation, and approach the animal gently. Sudden starts, and motions arising from fear, often do incalculable mischief in this complaint; which may be speedily removed, when timorously and cautiously treated.

Founder, has usually been mistaken for a disease of the loins or of the chest; but where its seat is forward, the fore feet will be found injured; in the former case the hind feet: this may be easily ascertained by observing whether the horse seeks relief from bringing the hind legs forward (as he stands in the stable) to support the fore quarters, or keeps the fore legs inclined considerably backwards, to support the hinder quarters: thus endeavouring to take the weight off the tender parts. When all the feet are affected, the horse lies down, and is unwilling, or perhaps unable to rise. This is usually a very troublesome complaint, and requires very copious bleeding, and every attention to ease and rest. The shoes ought to be taken off, and very soft litter be allowed, and frequently tossed up with the fork, to keep it from caking. Bleeding at the toes rarely fails of giving great relief; letting the blood flow freely. Endeavour, by all means, to prevent the collection of matter, as that always injures; indeed, after once suppuration has taken place, weakness, if not rottenness, will ensue in almost every case. Purge well, and keep the feet cool by the frequent application of salt and water, or sugar of lead in water, or sal-ammoniac and vinegar. Pare away the crust, so as to liberate the foot from its usual constriction. When recovering, we would recommend to turn the animal out into a rich soft paddock, if the season permits; or into a soft straw yard: the former is best, on account of the diet. Allow no corn, unless where the horse is extremely weak; and then scalded malt, &c. will answer best. In very bad cases, some have taken up the lateral arteries; but such seems to be a desperate course, and should never be practised where any hope

remains of success from milder treatment. When reduced to that extremity, the beast can be of no value.

Fractures and *luxations*, are subjects for the introduction of a surgeon: in most instances cures might be effected, provided the horse could be slung, so as to take the pressure entirely off from the limb. Iron frames, and very stiff splents, are sometimes used; but cannot always be had; neither are they applicable to every case. Nature in time will unite the bones of a simple fracture, after they have been set; but in general a callous protuberance is seen, which renders the animal less saleable; though the limb may be as serviceable as ever. We think it absurd to shoot a horse, merely because he has broke a bone which, by a little care, might be perfectly restored.

Grease is generally the effect of too rich food with little exercise; or it may be induced by bad standing, or by excess of labour; it is most frequent, and most difficult of cure, in very long limbed horses. Washing the legs without drying them is very apt to produce this disease, which is equally disposed to recur. If grease proceeds from redundancy, bleed, purge, and use gentle exercise, with moderate friction. When from weakness, or over labour, allow rest and nourishing food, giving good standing, and preserving perfect cleanliness.

Gripes have remissions of pain, which distinguish them from inflammation in the bowels, as does the disposition to roll on the back. Costiveness, bad food, drinking while warm, standing in the cold, especially after exercise, all cause this complaint. To cure it rake well, throw up clysters as warm as can be borne, and in large quantities. If the pain be very acute and obstinate, bleed copiously, and give a lump of opium, about the size of a large hazel-nut. But this must be done before any symptoms of inflammation appear. Foment the bowels with hot water, applied by means of blankets dipt therein. Give this draught as soon as possible: *viz.* castor-oil, one pint; oil of peppermint, one drachm; mix them with the yolks of two eggs, then add half a pint of water. If the bowels have not been well opened, let the following be given. Calomel, half an ounce; gum-gamboge, one drachm; Castile soap, half an ounce; make into a bolus with honey, and given at night; keeping on warm clothing, and cautiously avoiding a draught of wind.

Gutta serena, or *glass-eyes*, being absolutely incurable in horses, we shall not treat of it here, but refer to that head for a description of the disease as it affects the human eye.

Hepatitis, or inflammation of the liver, is usually induced by a morbid state of the parts secreting the bile, and may be known by a yellowness of the eyes and mouth, attended with considerable fever: in severe cases the horse is sometimes stiff in the off shoulder. Bleed freely, and blister the sides, applying numerous rowels underneath. Rake, and clyster; then purge well, by giving the following bolus, night and morning, till it operates freely. Calomel, half a drachm; aloes, one drachm and a half; Castile soap, two drachms; mix with honey.

Hydrophobia is incurable, however, if a large piece be taken out as soon as the horse has been bitten; or a fire-brand be quickly applied so as to burn a deep hole, or that lunar caustic be used, the animal may be saved; but such cannot be done in every part. Purge well, and administer mercurial preparations, so as to affect the system forcibly for a few days; gradually abating for a month, or more: if rapid symptoms appear, the horse should be instantly destroyed.

Jaundice may exist with or without any obvious inflammation of the liver; but should, for the sake of safety to the animal, always be considered as connected with hepatitis (which see.) If the symptoms be not urgent, the bleeding may be omitted; but purge well.

Inflammation, in whatever part, is generally the index to blood letting, either by opening a vein, by cupping, or by some other means. But local inflammations which seem to be critical, and push forward to suppuration, should rather be encouraged than resolved; unless they settle upon some part endangering the life. When the brain is inflamed, the lancet must be freely used, as must the blistering ointment and purges, together with whatever may tend to lessen the complaint in that part. The eye must, when in a state of irritation, be kept cool, and the habit lowered. Mild solutions of white vitriol, added to a few drops of extract of saturn should be applied, in the form of poultice, cold and frequently. When the stomach is inflamed, the horse should lose blood, and be clystered occasionally with soft cooling liquids. In cases of inflamed bladder, diuretics should be avoided; clysters should be occasionally administered, and mucilaginous, soothing drink be liberally given; such as decoction

of mallows, gum-arabic, linseed-tea, barley-water, &c. with regard to an inflammation of the liver we refer to hepatitis in this article. When the kidneys are inflamed, the treatment should be as in diseases of the bladder; observing, that the animal ought to be kept very low, after ample evacuations, both by bleeding and gentle purges; and that diuretics are highly prejudicial.

Lampes, is a swelling of the bars in the roof of the mouth, chiefly in young horses. But as, in such, the bars are always large, and appear to be swelled, be cautious in ascertaining that they really are so. When such is the case, by no means burn with a hot iron, as farriers too often do, but rub with alum and honey; if they do not subside, you may scarify the part very slightly with a sharp instrument, guarded with tow, &c. near its point, so that you cannot, in case of accident, do injury by making too deep a wound.

Lethargy, is often very slow in its approach, but sometimes equally rapid; in the latter instance rather tending towards epilepsy. It is occasioned in either case by too great a determination of blood towards the head. Bleed freely, unless when the debility is great; open the body by active purges, rake, and clyster, and endeavour to excite perspiration. Give the following: nitre, three drachms; resin, three drachms; cream of tartar, three drachms; all finely powdered, and mixed with honey into a bolus: repeat every morning, until the discharge of urine is abundant.

Mallenders, and *sellenders*, are scurfy eruptions about the knee, discharging a sharp ichor: they bear the first designation when within the front bending of the hock, the latter when they appear at the back of it. Wash with soap-suds, and apply the following: white vitriol, half a drachm; sugar of lead, half a drachm; tar, one ounce; mix, and rub in gently.

Mange, commonly arises from filth, or from poorness of condition, and is extremely infectious. Wash well with soap-suds, and apply the following: common brimstone, levigated, eight ounces; of alum and white vitriol each five drachms; horse turpentine, three ounces; lard, half a pound; mix, and rub frequently.

Pole evil, arises chiefly from friction of the collar at the back of the ears, or other such causes: it often forms a tumour, which must be brought forward, unless by blistering, &c. the fluid can be removed. Take care to open below the abscess, else there will be danger of sinuses. The sore is often extremely difficult to heal, and requires much patience: it will, however, generally yield to cleanliness, and due discharge downwards, by means of a seton smeared with mild blistering ointment: this ought to be kept in until the cavity is grown up, and in a manner grasps the seton.

Quittors, commonly are produced by the lodgment of filth about the coronet and surrounding parts: they should never be burnt, as is often practised by common farriers; but be kept very clean, and dressed twice daily with dijective ointment. If carbuncles, or proud flesh, should arise, take them down by means of lunar caustic. These sores are usually very tedious; but should not be hurried, as they are apt to break out afresh, or to run among the bones of the foot, when prematurely dried. Wash frequently with soap-suds, and put pledgets of lint, steeped in spirits of turpentine, until the sores appear clean and healthy.

Ring bone, is an exostosis, which partly surrounds the coronet: this, together with *splents*, *curbs*, *bone-spavins*, &c. may sometimes be cured by early attention; but when suffered to stand long, cannot be removed except by absolute force, such as sawing or chisseling them off. A strong preparation of corrosive sublimate, added to Spanish flies and Venice turpentine, and mixed with hog's-lard, will often dissolve a ring-bone, &c.; but much time is generally required to complete a cure.

Stag-evil, is properly the *tetarsus*, or locked-jaw. This is often caused by sudden changes from heat to cold: generally speaking the cure is very uncertain; but it will chiefly depend on opium, the warm bath, and other antispasmodics. Sometimes the sudden application of cold water in great quantities has been serviceable: friction of turpentine oil or spirits generally proves useful, as does a clyster made with 2 *oz.* of spirit of hartshorn, 4 *oz.* of oil of turpentine, and the yolks of three or four eggs; mixed with a quart of strong ale and gin. It is a great object to promote urine, sweat, &c.

Staggers, or *phrenzy*, is supposed to be a variety of the sleepy staggers, vertigo, or lethargy; only that in this instance the pressure on the brain is extreme, and the animal rendered outrageous. The causes are various; but for the most part this distemper arises from the critical termination of some other inflammatory disease. Sometimes it proceeds from a sun-stroke, and has been known to arise from the vicinity

of putrid matter: being suddenly changed from poor food to rich nourishing diet is a very frequent cause. To effect a cure, the horse should be bled copiously, from three to four quarts every eight hours, until the symptoms abate. Blister the head and neck with Spanish flies mixed in spirits of turpentine: rake well, and administer a strong clyster, so as to excite considerable discharge of excrement. Let the stables be very cool, and be sprinkled with hot vinegar. If possible to get a bolus down, let the following be given: calomel two drachms, aloes six drachms, Castile soap two drachms, mixed with honey. Allow very little drink. In desperate cases sling the horse, and throw cold water over his head and neck.

Stones in the bladder have been removed by cutting, the same as is practised when they form in the human bladder; but this is a very uncertain operation with cattle. When in the kidnies, stones may sometimes be brought down by strong diuretics; but, when so situated, the animal generally lingers a long time, and dies in great agony, perfectly emaciated. Horses also have stones occasionally in the intestines, generally in the cœcum, or blind gut. These induce frequent colics, and as they grow occasion much pain: unfortunately we know not of any means for their expulsion, or for their dissolution. Mares have been known to void great quanties of small stones, like pebbles.

Strangles rarely attack horses after completing their sixth year. This curious complaint has been compared to various diseases incident to the human frame, however, not with perfect propriety. It usually begins with a fever, a cough, a running at the nose, and a swelling of the sub-maxillary glands. If unheeded those glands will suppurate, rendering the cure very tedious, and in some degree dangerous. Repel, if possible, by copious bleedings, opening the body, exciting perspiration, and by gentle diuretics. Give the following, night and morning: nitre six drachms, cream of tartar six drachms, emetic tartar a drachm and a half, warm gruel one quart. Often great advantage is derived from blistering the throat, and from rowels in the chest. Strangles are supposed to be infectious; but we believe that point has never been fully ascertained. It may, however, be prudent to obviate any hazard of contagion.

Swelled legs usually proceed from weakness, and are very frequent after long indispositions, during which horses could not be duly exercised. Bleed freely, if the horse be in good condition, and lower his diet; use gentle exercise, and rub the part with flannel, or a soft brush: put on a stocking at night dipt in spirits of turpentine, with a little Goulard mixed. As the parts diminish gradually apply elastic rollers; but take care not to impede the circulation. Give very mild purges and diuretics, observing to keep the body gently open. If the complaint proceeds from debility, feed well, and proportion the exercise to the animal's powers: never fatigue him. But friction will on all occasions be found the safest, and the most effectual remedy. The stable should be kept cool, and sweating should be particularly avoided, since it would increase the complaint. In some strong habits rowels in the thighs may be advantageously made.

Thrush, or *running-thrush*, is a discharge from the sensible frog, which soon becomes deeply diseased, if the pressure, &c. which occasioned the complaint be not removed. It chiefly takes place in narrow heels, especially where the frog has been cut away, and the heels left high. The running ought to be dried, taking care to bring the frog into action by lowering the heels gradually, and bearing upon it by means of a bunch of tow. Use this wash frequently, as warm as it can be borne: tar two ounces, oil of vitriol six drachms. Gentle purges and mild diuretics will greatly aid towards a cure, if the habit be full, and the discharge considerable. Horses that have bad standing are very subject to this complaint: in fact, dirty, damp stables give birth to an infinity of diseases.

Ulcers invariably require soft dressings, and that their edges should be kept low, and free from callous or horny matter. Dress often, and in case of a sinus be careful to have the vent downwards, so that the discharge may be free. We have not any complaint more various than this, nor one more difficult to heal. Indeed, in some instances that should not be attempted. Cleanliness and mild treatment are indispensable. If fungus flesh should arise, or the edges become hard, touch with blue vitriol, or with lunar caustic, and make way for the flesh to granulate, and for the skin to collapse. When the habit is foul, topicai applications alone will not answer; alteratives must be given, and the diet be such as may check the acrimony. When the wound cicatrizes, apply a little lard very gently to

soften the skin; and if the flies are troublesome, mix a very small quantity of tobacco in the lard.

Warbles, form under the saddle, in consequence of unequal pressure. Perfect rest is the best remedy; but a solution of sugar of lead in vinegar will greatly promote dispersion. If the warbles become firm, (*i. e.* sit-fasts) blister them, or, if necessary, let them be carefully extirpated by the knife.

Wind-galls must be removed by firm pressure on a bolster that immediately sets upon the swelling: when subdued the part should be fired, to prevent recurrence of the complaint. The sweating blister, made by steeping Spanish flies in vinegar, often has a fine effect, as will any preparation that causes speedy evaporation; but the compress is what we chiefly advise: for unless the parts be brought together by pressure, the object will rarely be attained.

Worms frequently cause extreme indisposition before their existence is even suspected: many horses have, indeed, died in consequence. It is proper therefore to state, that when a horse rubs his tail, and that a yellow matter appears at times about the anus, worms may be suspected; especially if he eats heartily, yet has a staring coat, and does not thrive; or that he stands with his hind legs straddling, has slight attacks of gripes, and frequently turns his head towards his belly, which commonly appears large and low. Bots may often be found among the dung; these are very tenacious of life, and resist most of our strong vermifuges. Common salt is one of the most powerful remedies; but subjects the horse to considerable inquietude. The root of the male fern, levigated, and given fresh, is highly extolled, as is soot also. But we believe that strong doses of calomel and gamboge will be found the most efficient, provided they be persevered in, so as to scour for a number of days, or even perhaps a fortnight, in succession; but this must greatly depend on the condition and constitution of the horse. The teretes, or long round worms, are commonly white, about ten inches in length, and require very strong purges to dislodge them. The ascarides, which are very small worms, scarcely longer than a common needle, are not so bad as the preceding in their effect on the intestines, but give considerable uneasiness. We recommend the continued purge, as affording the best prospect of expulsion.

Under the article Equus the reader will find what appertains more particularly to the nature of that useful animal: we shall conclude this with strongly inculcating the expediency of avoiding communication with farriers, and in advising the introduction of regular medical or surgical aid, whenever horses suffer under such indisposition as cannot be removed by the cheap and simple recourse to good bedding, ease, moderate warmth, generous diet suited to the case; and where there appear inflammatory symptoms, to bleed to the amount of two, three, or even four quarts, substituting diluent beverage, such as warm hay or linseed-tea, or scalded bran or malt, in lieu of more substantial food. By such attention, and by forbearance from violent or harsh measures, we have seen horses speedily recover from complaints that, under the farrier's auspices, would have induced long disease, and a long bill. There will be found in every town some person capable of giving advice at least; and in most places some one of the profession will be found willing to take charge of a sick horse. Formerly, indeed, such a request would have appeared an affront; but in these more enlightened times that apprehension need not be entertained: indeed many eminent surgeons pride themselves on a familiar acquaintance with veterinary subjects. Perhaps we may be right in observing, that the designation of *horse-doctor* being banished from our country establishments, to make way for the more respectable title of *doctor of horse*, has not a little contributed towards the present liberality of sentiment to this useful profession.

To such readers as may be desirous of obtaining a full acquaintance with the subject, we recommend personal application to Mr. Coleman, and that they subscribe to the college fund. By such means they will derive the utmost advantage from the liberality and abilities of that gentleman, and gradually become competent to the treatment of the most ordinary class of accidents and distempers. Mr. Coleman's work will also be found a cheap and highly useful member of the library.

FASCIÆ, in astronomy, certain parts on Jupiter's body resembling belts or swathes. They are more lucid than the rest of that planet, and are terminated by parallel lines, sometimes broader and sometimes narrower. M. Huygens observed a fascia in Mars much broader than those of Jupiter, and possessing the middle part of his disk, but very obscure.

FASCINES, in fortification, faggots of

small wood of about a foot diameter, and six feet long, bound in the middle and at both ends. They are used in raising batteries, making chandeleers, in filling up the moat to facilitate the passage to the wall, in binding the ramparts where the earth is bad, and in making parapets of trenches to screen the men.

FASCIOLA, in natural history, *gourd-worm*, a genus of the Vermes Intestina class and order. Body flattish, with an aperture or pore at the head, and generally another at a distance beneath, seldom a single one. About fifty species have been described. They are divided into different sections, *viz.* those infesting mammalia, birds, reptiles, fish, and worms: among the first is F. hepatica, which is found in the liver of sheep, and is often vomited in brooks, and is generally found fixed by a pore at the extremity, and another in the middle of the abdomen, and occasions dropsy, and the disorder which is called the rot. The body of this animal is about an inch long, broader on the fore-part, and terminated by a tube; the back marked with about eight longitudinal furrows in two series.

FAT, an oleaginous or butyraceous matter, secreted from the blood, and filling up the cavity of the adipose cells. See ANATOMY.

FATA *morgana*, a very remarkable aerial phenomenon, which is sometimes observed from the harbour of Messina and adjacent places, at a certain height in the atmosphere. The name, which signifies the fairy morgana, is derived from an opinion of the superstitious Sicilians, that the whole spectacle is produced by fairies, or such-like visionary invisible beings. The populace are delighted whenever it appears, and run about the streets shouting for joy, calling every body out to partake of the glorious sight. This singular meteor has been described by various authors; but the first who mentioned it with any degree of precision was father Angelucci, whose account is thus quoted by Mr. Swinburne in his tour through Sicily: "On the 15th of August, 1643, as I stood at my window I was surprised with a most wonderful delectable vision; the sea that washes the Sicilian shore swelled up, and became for ten miles in length like a chain of dark mountains; while the waters near our Calabrian coast grew quite smooth, and in an instant appeared as one clear polished mirror reclining against the ridge. On this glass was depicted, in chiaro-scuro, a string of several thousand of pilasters, all equal in altitude, distance, and degree of light and shade. In a moment they lost half their height, and bent into arcades, like Roman aqueducts. A long cornice was next formed on the top, and above it rose castles innumerable, all perfectly alike. These soon split into towers, which were shortly after lost in colonnades, then windows, and at last ended in pines, cypresses, and other trees, even and similar. This is the fata morgana, which for twenty-six years I had thought a mere fable." To produce this pleasing deception, many circumstances must concur which are not known to exist, at least to the same extent, in any other situation. The spectator must stand with his back to the east, in some elevated place behind the city, that he may command a view of the whole bay; beyond which the mountains of Messina rise like a wall, and darken the back-ground of the picture. The winds must be hushed, the surface quite smooth, and the tide at its height. All these events coinciding, as soon as the sun surmounts the eastern hills behind Reggio, and rises high enough to form an angle of forty five degrees on the water before the city, every object existing or moving at Reggio will be repeated a thousand-fold, as if in a looking-glass composed of facets or planes inclined to each other. Each image will pass rapidly off in succession, as the day advances, and the stream appears to carry down the face upon which it appeared. Thus the parts of this moving picture will vanish in the twinkling of an eye. Sometimes the air is at the same moment so loaded with vapours, and undisturbed by winds, as to reflect objects in a kind of aerial screen, rising about thirty feet above the level of the sea. In cloudy heavy weather they are drawn on the surface of the water, bordered with fine prismatic colours.

Father Antonio Menasi published an express treatise at Rome, in 1773, entitled "Dissertazione prima sopra un fenomeno volgaremente detto Fata Morgana," of which a short abridgement is given in Nicholson's Journal, 4to. vol. i. p. 225, with a large engraving. This author does not appear to have philosophized successfully upon the appearances, which are, indeed, very far from having been at all explained. The reader, who may wish to consider the facts, is referred to Huygens, "De Coromis et Parhelus;" Priestley's "Optics for Atmospheric Phenomena;" Huddart in the Phil. Trans. 1797; Vince, in the same work

for 1799; and Wollaston for 1800; which three last are in the journal last quoted. The fata morgana seems to depend upon the general principles of looming, which Wollaston has very successfully displayed, together with the reflection from particles of water floating in the air. These particles doubtless assume prismatic figures by coagulation; and it is, perhaps, a mistake to suppose them to be spherical, even at their primary condensation, in the fluid state of minute floating particles.

FATHOM, a long measure containing six feet, chiefly used at sea for measuring the length of cables and cordage.

FEATHER, in physiology, a general name for the covering of birds; it being common to all the animals of this class to have their whole body, or at least the greatest part of it, covered with feathers or plumage.

There are two sorts of feathers found on birds, *viz.* the strong and hard kind, called quills, found in the wings and tail; and the other plumage, or soft feathers, serving for the defence and ornament of the whole body. All birds, so far as yet known, moult the feathers of their whole body yearly.

The feathers of birds make a considerable article of commerce, particularly those of the ostrich, heron, swan, peacock, goose, and other poultry; for plumes, ornaments of the head, filling of beds, and writing pens. There are scarcely any birds but what bed-feathers may be procured from, particularly those of the domestic kind; yet swans, geese, and ducks, are those that furnish most, and the best. Geese are plucked three times a year, towards the end of May, about Midsummer, and at the latter end of August; but chiefly when the feathers are ripe, that is, when they are perceived to fall off of themselves. The feathers of dead birds are in the least esteem, upon account of the blood imbibed by the quill, which putrifying, communicates an offensive smell to the feather, and takes some time to evaporate; for which reason live birds should not be stripped till their feathers are ripe. They are imported in this country from Poland and Germany. They are divided in white, half grey, and grey, and valued accordingly. The best feathers should be white, downy, void of large stems, fresh, and sweet. Care should be taken that no sand be intermixed, which is frequently practised to encrease the weight. Ostrich feathers are dyed and dressed by the feather-dressers, to serve as ornaments. They are a very costly article, brought to us from Africa, and particularly the coast of Barbary. See Down.

FEATHER *edged*, among carpenters, an appellation given to planks or boards, which have one side thicker than the other.

Feather, *prince's*, a plant otherwise called amaranth. See Amaranthus.

FECES. The excrementitious matter of animals, evacuated per anum, consists of all that food which cannot be employed for purposes of nutrition, considerably altered, at least in part, and mixed or united with various bodies employed during digestion to separate the useless part of the food from the nutritious. An accurate examination of these matters has long been wished for by physiologists, as likely to throw much new light on the process of digestion; but it must be admitted that our knowledge on this subject is still very imperfect. Some of the older chemists have turned their attention to the excrements of animals; (Van Helmont's Custos Errans, sect. 6; Opera Helmont, p. 247; Neumann's Works, p. 585.) but no discovery of importance rewarded them for their disagreeable labour. Vauquelin has ascertained some curious facts respecting the excrementitious matter of fowls; and in the summer of 1806, a laborious set of experiments on human feces was published by Berzelius, undertaken, as he informs us, chiefly with a view to elucidate the function of digestion. (Gehlen's Jour. VI. 509). About two years before, Thaer and Einhof had published a similar set of experiments on the excrements of cattle, made chiefly to discover, if possible, how they act so powerful as manure. (Ibid III. 276).

The human feces, according to the experiments of Berzelius, were found to contain

Water	73.3
Vegetable and animal remains	7.0
Bile	0.9
Albumen	0.9
Peculiar extractive matter	2.7
Salts	1.2
Slimy matter, consisting of resin of bile, peculiar animal matter, and insoluble residue	14.0
	100.0

To Vauquelin we are indebted for an analysis of the fixed parts of the excrements of fowls, and a comparison of them with the fixed parts of the food; from which some

very curious consequences may be deduced.

He found that a hen devoured in ten days 11111.843 grains troy of oats; these contained

136.509 grains phosphate of lime
219.548 silica
356.057

During these ten days she laid four eggs, the shells of which contained 98.776 grains phosphate of lime, and 453.417 grains carbonate of lime; the excrements emitted during these ten days contained 175.529 grains of phosphate of lime, 58.494 grains of carbonate of lime, and 185.266 grains of silica; consequently, the fixed parts thrown out of the system during these ten days, amounted to

	274.305 grains phosphate of lime
	511.911 carbonate of lime
	185.266 silica
Given out	971.482
Taken in.	356.057
Surplus...	615.425

consequently, the quantity of fixed matter given out of the system in ten days, exceeded the quantity taken in by 615.425 grains,

The silica taken in amounted to...............	219.548 grains
That given out was only......	185.266 grains
Remains.........	34.282

consequently, there disappeared 34.282 grains of silica.

The phosphate of lime taken in was............ ..	136.509 grains
That given out was............	274.305 grains
	137.796

consequently, there must have been formed by digestion in the fowl, no less than 137.796 grains of phosphate of lime, besides 511.911 grains of carbonate; consequently, lime (and perhaps also phosphorus) is not a simple substance, but a compound, formed of ingredients which exist in oat-seed, water and air, the only substances to which the fowl had access: silica may enter into its composition, as part of the silica had disappeared; but if so, it must be combined with a great quantity of some other substance. (Ann. de Chim. xxix. 61).

'These consequences,' as Dr. Thompson observes, whom we follow in this article, 'are too important to be admitted without a very rigorous examination. The experiments must be repeated frequently, and we must be absolutely certain that the hen has no access to any calcareous earth, and that she is not diminished in weight; because, in that case, some of the calcareous earth of which part of the body is composed, may have been employed. This rigour is the more necessary, as it seems pretty evident from experiments made long ago, that some birds, at least, cannot produce eggs unless they have access to calcareous earth. Dr. Fordyce found, that if the canary bird was not supplied with lime at the time of her laying, she frequently died, from her eggs not coming forward properly. (On Digestion). He divided a number of these birds, at the time of their laying eggs, into two parties: to the one he gave a piece of mortar, which the little animals swallowed greedily; they laid their eggs as usual, and all of them lived; whereas many of the other party, which were supplied with no lime, died."

Vauquelin also ascertained, according to Fourcroy, that pigeon's dung contained an acid of a peculiar nature, which encreased when the matter is diluted with water; but gradually gives place to ammonia, which is at last exhaled in abundance. (Fourcroy, i. 70).

FEE, in law, *feudum, beneficium,* all land in England is in the nature of a feud or fee, and subject to the original conditions of the grant, which is supposed to come from the crown; but now that distinction is very immaterial.

Fee *simple,* is an estate to a man and his heirs, and is the largest estate which one can have; it descends to heirs of all kinds, and may be granted or devised at pleasure. When it is created by deed, it must be expressly stated to be to the grantee and his heirs; for an estate to A, for ever, is only good for life: in a will, however, this strictness is not required; any words which shew the intent of the testator will be sufficient. In a deed, a man cannot give a fee-simple to one, and then afterwards, in case he dies without heirs, to another. In a will, words which import this, are often construed only to give the first taker an estate tail. It may be forfeited for treason or felony. Upon an exchange, a fee may pass without expressing the word heir; so also on a fine or recovery. A grant to the King, or a corporation, sole for ever, necessarily gives a fee, because they never die.

FEELERS, in natural history, a name used by some for the horns of insects.

FEELING, one of the five external senses, by which we obtain the ideas of solid, hard, soft, rough, hot, cold, wet, dry, and other tangible qualities. This sense is the coarsest, but at the same time, the surest of all others; it is besides the most universal. We see and hear with small portions of our body, but we feel with all. Nature has bestowed that general sensation wherever there are nerves, and they are every where, where there is life. Were it otherwise, the parts divested of it might be destroyed without our knowledge. It seems that upon this account, nature has provided that this sensation should not require a particular organization. The structure of the nervous papillæ is not absolutely necessary to it. The lips of a fresh wound, the periosteum, and the tendons, when uncovered, are extremely sensible without them. These nervous extremities serve only to the perfection of feeling, and to diversify sensation. Feeling is the basis of all other sensations.

FELAPTON, in logic, one of the six moods of the third figure of syllogisms, wherein the first proposition is an universal negative, the second an universal affirmative, and the third a particular negative.

FELIS, the *cat*, in natural history, a genus of Mammalia of the order Feræ. Generic character: six foreteeth, intermediate ones equal, three grinders on each side; tongue prickly backwards; claws retractile. Animals of this comprehensive class never unite in companies for mutual defence, but accomplish their ferocious and bloody purposes with solitary energy. They are swift and strong, have many of them, a peculiar facility in climbing trees, and falling from any considerable height, alight on their feet. They spring on their prey with the suddenness of lightning, and suck its blood before they devour it. They will eat vegetables, only when other food is not within their reach. They are principally distinguished by their large and pointed claws, which are lodged in a sheath, and protruded or withdrawn at pleasure. The numerous species of this genus differ extremely in size and in colour, but in form and character, possess a family resemblance, and are crafty, fierce, and sanguinary. There are twenty-three species, of which we shall notice those which follow:

F. leo, or the lion. This is the largest species of the Felis genus, and has occasionally been known to measure eight feet in length, exclusively of its tail, which is about three or four. Its colour is of a pale tawny, and the male possesses an extremely full and flowing mane. The female is destitute of this, and is considerably smaller than the male. It has been known to live in a state of confinement, to the age of sixty-three, or seventy years, though from a philosophical examination of its general structure, it would be concluded that its average duration would not exceed twenty-five. The parental affection of the lioness is extreme: in support of her young she braves the most formidable dangers, and is wrought up to a pitch of agitation and exertion, which render her in such circumstances, a more terrible adversary than the lion himself. She produces her young in the most remote and sequestered situations, and to provide for their wants, engages in the most rapid excursions, and most daring attacks, returning to her cubs with the fruit of her toils and dangers, with the most impatient impetuosity, and feeding them with the yet convulsed members of her prey. It is reported, by some authors, that she endeavours, occasionally, to obscure the track to her den by brushing out the marks of it with her tail, and when suspicious of particular danger to her young, will remove them in her mouth to a place of greater security, with looks of unutterable menace and antipathy at any creature, however formidable, which may shew the slightest disposition to impede her progress. She produces but one litter, consisting of four or five in number, in the year. These are at first extremely small, little exceeding the size of a half grown kitten, and they are five years in attaining their full growth.

The lion is found in the warmer regions of Asia, but attains his highest perfection in the interior of Africa. His strength is such, that with a single stroke of his paw he has broken the back of a horse, and he has been known, not unfrequently, to carry off a young buffalo between his teeth. He rarely engages in full daylight in the pursuit of prey, but on the approach of night quits his habitation, and with a roar which can be resembled only to a peal of thunder, and overwhelms the other inhabitants of the wilderness or forest with consternation, commences his career of havock. His sense of smell is far from being acute, and he depends in the chase only upon actual sight or probable inference. He frequently consumes at one repast sufficient to satisfy him for two or three days; he breaks the bones of the buffalo with perfect

ease and frequently swallows them; and the reversed prickles on his tongue are of extraordinary strength and extension. After a full repast, he returns to his den and enjoys a state of slumber and repose, till the calls of hunger rouse him to fresh activity, and impel him to recommence the work of blood. The lion, in the exertion of his full energies, must present one of the most impressive images that can be conceived. The general majesty of his countenance, surrounded by his full mane intensely erected, and lighted up by the glaring indignation of his eye, connected with the thunder of his voice, and all the apparatus of destruction in his mouth and paws, has in every age, caused him to be considered as furnishing admirable materials for sublime and terrific imagery.

At the Cape of Good Hope, it is by no means uncommon to hunt the lion, and in an open and spacious plain, in which he finds it impossible to escape his pursuers by flight, he checks his progress, and fronts his adversaries awaiting their attack. Several of the dogs which first dare to assault him, generally fall under his stroke, but in a few moments he is overwhelmed by numbers, and literally torn to pieces. The negroes of the Cape are reported to eat his flesh; and his skin, which was formerly deemed a mantle for a hero, is now more frequently employed for the bed of a Hottentot.

It is imagined that lions are inexpressibly less numerous in Africa now than formerly, and it is stated by Shaw, that all Libya could at this time scarcely supply that number, which was sometimes exported to Rome, even in a single year. In proportion as population has extended, and national intercourse has advanced, their range has necessarily become more limited, and their acquaintance with man seems to have considerably checked that daring, which was supposed by many incapable of being daunted. The lion's valour diminishes in proportion as he resides near the habitations of men, whose ingenuity and resources he seems well aware must always secure them a superiority in the conflict with other animals, and whose appearance, therefore, he shuns as that of his most formidable adversary. In the neighbourhood of the small towns of Africa, even women and children have not unfrequently driven lions from their lurking places. When taken young, they can be taught to sustain confinement without difficulty, and will not only manifest tranquillity and contentment, but occasionally engage in sports and gambols with smaller animals, among which they have been led to associate. They are susceptible of attachment and gratitude, will caress their keepers, display a magnanimous forbearance with respect to the offensive freedom and petulant insults of weaker creatures, and after having once, as it were, pledged themselves for the security of any which, by an act of wantonness, may have been thrown as victims into their den, will endure extreme hunger before they can permit themselves to destroy them. The natural excitability of these animals, however, is so great, that all the discipline of education is frequently insufficient effectually to repress their passions within secure limits, and in some unlucky coincidence of circumstances, those familiarities with them which had been permitted without the slightest resistance, or reluctance, have proved fatal to the persons who engaged in them. Though the lion frequently attacks his prey in open chase, he generally adopts the system of ambuscade, and will lurk on his belly in some thicket, frequently near the water, awaiting the approach of any animal which its evil destiny may impel near it, on which he will spring with a sudden bound, rarely failing of success, and sometimes reaching to the distance of twenty feet. When this leap is unsuccessful, the object is permitted to escape without pursuit, and he retraces his steps slowly to the thicket, as it were abashed by his failure, and anticipating the consequences of greater adroitness in his ensuing effort.

Lions have in various countries been employed as emblems of state, and insignia of sovereignty. In Persia, two large lions with fetters of gold are stationed on days of peculiar ceremony and splendour, on each side of the hall of audience; and in Rome, Anthony was drawn through the streets by lions harnessed to his chariot. To furnish entertainment for the inhabitants of that splendid and luxurious city, lions were conveyed in vast numbers from the interior of Africa, to exhibit at the public festivals, at which they fought with each other, with other animals, and even at length with men. This diversion was first exhibited by Quintus Scævola, but was afterwards carried to far greater extent. Sylla displayed in the Arena, a hundred lions during his pretorship. Julius Cæsar, to conciliate the people, entertained them

with no fewer than four hundred; and Pompey imported at vast expence, and with the most elaborate research, the immense number of three hundred and fifteen males, and two hundred and seventy-five females. For the lion and lioness, and their whelps, see Mammalia, Plate XIII.

F. tigris, the tiger. This is called by Linnæus the most beautiful of quadrupeds, a character, which would not be thought correctly applicable, were the judgment on this subject to be determined from the skins in a museum, or from a view of the animal itself, in that confined state in which it must ever appear in this country. But in its native region, and unchecked health and energies, it exhibits a bloom and radiance unequalled by any of the brute creation. Its ground colour is an intense orange colour, and defined stripes of pure black, in some parts double, and in others single, mark its body tranversely, extending through the clear white of the sides. It is little inferior in size to the lion, and in some instances has been seen even larger than any lion mentioned by travellers, extending from the nose to the end of the tail, to fifteen feet in length. Of all the carnivorous tribes, this species is considered as the most sanguinary and destructive. It appears to delight in the infliction of pain and the effusion of blood. After satisfying its hunger it still continues to worry and destroy. If unmolested in the enjoyment of its prey, it will absolutely bathe its head in the blood and entrails of its victim, and while exhibiting this spectacle of horror, appear to enjoy that ecstacy, which arises necessarily from the gratification of the most impetuous and irresistible instincts. Though frequently confined, its ferocity is incapable of being subdued, and those sports, or freedoms, on the part of its keeper, which the lion admits with impunity, if not with satisfaction, would be fatal to the man who should dare to attempt practising them with the tiger. Tigers are found only in Asia, and attain their perfections of size and beauty, and their extreme degree of rapacity and fierceness in India, where they commit often the most dreadful havoc, and lurking among thickets, and near villages, assault unwary travellers as well as the inferior animals; and in districts thinly peopled, are the most dreadful terror and plague of the inhabitants. They seldom, if ever, engage in the violent and persevering chase of any animal, but practise almost uniformly, the mode of ambush, rushing on their victim with almost unerring accuracy, and making those extensive bounds, which can result only from superlative elasticity and vigour.

The name tiger, in the language of the Armenians, signifies an arrow, and aptly expresses the agility of those movements, by which these animals seize upon their prey. The sounds which they utter in this moment of seizure, are stated to be the most hideous and appalling that imagination can conceive. Animals of considerable size are not only attacked by a tiger without the slightest hesitation, but give no impediment from their bulk to his carrying them off to some thicket, where he may enjoy in unmolested solitude, his feast of carnage. A man, or even a young buffalo, has been thus disposed of by him with great facility, and after sucking the blood of his victims with the most intense application, he proceeds to tear them in pieces and devour them. Conflicts, are reported by travellers, not unfrequently to occur between the lion and the tiger, carried on with all that intrepidity and perseverance, with all that energy and fierceness, which might naturally be expected, and ending sometimes only in the complete destruction or mutilation of both. At Siam it is not unusual for elephants to be baited by a tiger, constituting a similar display of savage power and skill, with what is afforded in this country by a bull and dogs. Two elephants, well defended by artificial guards on their heads and great part of their trunks, are related in one instance, to have been introduced to the arena, where was a tiger tethered by cords: one of the elephants approaching it while under this extreme disadvantage, struck it several heavy blows on its back, and laid it motionless on the ground; it was then untied, and soon afterwards, being considerably recovered, it bounded with an immense spring and a most hideous roar at the trunk of its antagonist, who parried the attempt with astonishing adroitness, and receiving the tiger on his tusks, hurled it into the air. The other elephant was at this time unfairly allowed to join its companion, and each inflicted several severe blows on their common enemy, who must have perished, indeed, under their united efforts, if the fight had not been terminated at this crisis by the governors' command. The boldness and vigour of the tiger were sufficiently displayed, however, and considering the restraints under which he laboured, and his

continued combat, notwithstanding the first and almost fatal discomfiture, were truly admirable.

It is recorded by Mr. Pennant, that in the beginning of the last century, as a British party in India were indulging themselves in rural recreation and festivity, totally unsuspicious of danger, an immense tiger was seen advancing towards them, and was so near as to be almost in the act to bound upon them. Dismay and consternation instantly pervaded every individual present but one, who was a lady, and who, with a promptness and self-possession, probably never exceeded, furled a large umbrella in the face of the tiger, and thus most happily effected its retreat.

The catastrophe of Mr. Monro, in similar circumstances, was recorded by one of his companions, and may be not improperly noticed in this connection. In the year 1792, several British gentlemen, together with Mr. Monro, went to shoot deer on Sangar island, on the shores of which they observed innumerable traces of the feet of both these animals, not only of the deer, but of the tiger. They continued their sport, however, for a very considerable time, and after completing it, were sitting down for refreshment near a jungle, when a tiger, with a most horrible roar, darted from the jungle, and seizing on Mr. Monro, hurried back with him to the thicket, dragging him through the thickest bushes with amazing rapidity, and making every thing bend and yield to its prodigious strength. A tigress accompanied it in its progress. The tiger was fired at by the two remaining gentlemen, and was obliged to drop its prey; and in a few moments afterwards their unfortunate friend was advancing towards them weltering in his blood. He had received, however, such deep wounds from the teeth and claws of the tiger, as precluded the possibility of recovery, and after twenty-four hours of agony he expired. The scene was dreadful beyond all the expression of words. At the time of the assault, an immense fire of several whole trees was burning by the spot, and shortly after their departure from these fatal shores, the gentlemen observed the tigress to make her re-appearance in all the agitation of unbounded fierceness and disappointed vengeance. The tigress produces but one litter, consisting generally of five young, in a year. In her defence of these, that fury which, even, in ordinary times, seems to mark her character, is wrought up to a paroxysm, in which she defies all danger, and exposes herself frequently to certain destruction. See Mammalia, Plate XIV. fig. 3.

F. pardus, the panther. It was for some time a question whether the panther were not to be found in the new as well as in the old world; it is now, however, fully ascertained not to belong to America. It is found in Africa from the coast of Barbary to the south of Guinea, in the last of which it is found in considerable numbers. Its length is about six feet and a half without the tail, which generally measures three; its colour is a bright tawny yellow, thickly studded along the upper part of its body, with circles of black spots containing a single spot in the centre. It is extremely ferocious, and its depredations in Africa resemble those of the tiger in Asia; though the panther, indeed, abstains, unless when urged by extreme hunger, from attack on man. Its mode of attack is always by surprise, and bursting from the thicket with an immense spring, or approaching with extreme silence and caution on its belly, it lights instantly upon its prey, and the moment of alarm is made by it, frequently, the moment of destruction. In China, where the skins of beautiful and brilliant quadrupeds are in high estimation, there is a variety of this species, the skin of which is sold for about six guineas. The number of panthers imported by the rich and ambitious among the Romans, to supply the popular sports of that city, is almost incredible; four hundred and ten were exhibited by Augustus within only a few days, and the immense demands which were made on Africa for this purpose, tended at length to render them procurable in the territory of Mauritania, only with very great labour and expense. In that country they are at present rare, comparatively with what they must have been before those vast exportations; but farther to the south they are extremely numerous. See Mammalia, Plate XIV. fig. 2.

F. leopardus, or the leopard. This animal is principally distinguished from the preceding by its less lively yellow colour, its inferior size, and the closer arrangement of the spots with which it is diversified. Its manners are similar to those of the panther, and both inhabit the same territories. Among the vast herds of Lower Guinea they commit the most destructive havoc;

and when they are impelled by hunger, every creature is exposed to their attack. They are often taken in pit-falls by the negroes, who highly value their flesh, which, in appearance, is not a little like that of veal; their teeth are arranged in fanciful dispositions by the women of the country, and hung about their necks and arms, both as amulets and ornaments; and their skins are exported to various parts of Europe, where they are particularly admired, and are sold for corresponding prices. There is in India a variety of this species trained with great success to hunt the antelope and other beasts. It is conveyed in a small vehicle to the spot of its intended exertions, and chained and hooded till it is let down as near to the herd as is thought convenient; it then makes every effort to reach them unobserved, advancing with extreme vigilance and caution, and when it perceives itself in a proper situation, it rushes with a succession of amazing bounds, five or six in number, towards its destined object, and is almost uniformly successful in securing it. On failure it returns to its owner, and after a short interval recommences its efforts. See Mammalia, Plate XIV, fig. 1.

F. uncia, or the ounce, is about three feet and a half in length, and has a skin beautifully varied with single spots, or oval collections of them, on a light-grey ground-colour. It is a native of China, Persia, and Barbary. Its sense of smell is not extremely acute, but its eye possesses exquisite discernment, on which account it is disciplined to the chase with wonderful success; and so gentle are its manners that it is taken to the hunt on the crupper of the horse, behind its owner. It is not remarkable for speed in running, or at least for a continuance of rapid exertion, and is, indeed, incapable of it; but it seizes its prey by a few rapid bounds, in which it displays astonishing nimbleness and dexterity. It frequently ascends trees, from which it may dart on any animals leisurely and fearlessly passing beneath.

F. onca, the jaguar, is the most formidable of all the animals found in the new continent, and abounds particularly in the Deserts of Guiana; in passing which the Indians, who have an extreme dread of this animal, always kindle fires to keep it at a distance. Its ground colour is a light brownish-yellow, which is varied with streaks and open spots of black. It is rather larger than a wolf, but is said to find a formidable, and often fatal, antagonist in the ant-eater, which, on being attacked by the jaguar, throws itself on its back, and with its long claws fixes on his throat and kills him by suffocation.

F. puma, or the congouar, has by some been called the American lion, but is unworthy of a comparison with the sovereign of the forest. It is, however, the largest of the American beasts of prey, and is extremely fierce and ravenous. It inhabits in many parts from Canada to Florida, and is found also in Mexico and Brazil. In the warmer climates it possesses its greatest perfection in vigour and courage, and will frequently cross rapid torrents to seize cattle grazing in inclosures near the habitations of man. It has been known to attack a wolf. It is a formidable enemy to the moose-deer, and others of that tribe; and will often mount trees to watch the animals that pass beneath, selecting the victims of its rapacity, and quitting them only after having exhausted their last drop of blood. This fierce animal, strange as it may appear, if taken young is trained to become as inoffensive nearly as the common cat, and will permit, without rage or resentment, all the rough caresses and violent gambols of boys.

F. discolor, or the black tiger, is considered by many only as a variety of the former species. It is exceedingly strong in its limbs, and attains the size of a heifer of a year old. It is found in Brazil and Guiana; and is rapacious and savage in its disposition; and fortunately, therefore, not abundant. It eats the buds of the Indian fig occasionally, but more frequently the eggs of turtles deposited on the shore. Lizards, fishes, and young alligators, are all made prey by it. It swims with great rapidity. In quest of the alligator it employs the stratagem of lying down on its belly at the edge of the water, and striking it with its paws; the noise and motion induce the alligator to lift its head above the surface, when the claw of the black tiger is instantly fixed in its eye and drags it to the land.

F. pardalis, or ocelot, is about four times the size of a domestic cat, the shape of which it extremely resembles, and is one of the most beautiful of all variegated quadrupeds. It is a native of South America, and particularly destructive, which may be, in a great degree, accounted for from the circumstance of its seldom devouring the flesh of animals, rather thirsting, with insatiable avidity, for their blood. In the

mountainous tracts of Mexico and Brazil these animals are abundant, hiding themselves amidst the foliage of trees, whence they spring upon their prey beneath. They are reported frequently to stretch themselves out motionless on the branches of trees, to induce the monkey to approach and examine them, which with his usual curiosity he is in such circumstances prompted to do; this curiosity, however, is only the instant prelude to his destruction. These animals are scarcely capable of being tamed, and in captivity display incessant restlessness and ferocity.

F. tigrina, or the Cayenne cat, resembles the wild cat in size, habit, and character; is most elegantly spotted with black on a tawny ground, and is frequently to be found in various parts of South America. It is extremely wild and untameable. The spotted species of this genus of animals have been often so imperfectly marked by travellers, that much remains to be done before a complete description of them can be obtained: and the remoteness of their haunts from human habitations, which can be approached only amidst dangers insuperable by all but extraordinary minds and constitutions, will, there is reason to presume, long preclude their correct definition and full detail.

F. catus, or the common cat. The numerous varieties of the domestic cat are supposed to have proceeded from a race native in the north of Europe and Asia. In the wild state its tail is somewhat shorter than in the state of domestication; its head is more flat, and its limbs are more muscular and bony. The general colour of the wild cat is that of a pale yellowish-grey, with dusky stripes and variegations; there are, however, great varieties both of colour and size. Wild cats are found not only in Europe and Asia, but also in America, where they existed before its discovery by Columbus. In Great Britain they are found chiefly in the mountainous and woody districts of the island; and, as being the most rapacious quadrupeds in the country, have been designated by Mr. Pennant as the British tigers. They range by night in quest of prey, and commit fatal depredations on kids, poultry, and lambs; they likewise devour hares, small birds, and various species of vermin. They breed and principally reside in trees; and are equally prolific with the domestic cat. In the neighbourhood of the former the latter will often quit its residence for a short time, and after associating during this interval with the wild cat, will return to its former mansion. These animals are frequently destroyed by means both of traps and guns; the latter of which mode, however, is attended with some danger, as, if only slightly wounded, they will, without hesitation, attack the assailant in their turn and inflict no contemptible revenge. In the county of Cumberland one of these animals was killed, not many years since, which measured from its nose to the end of its tail upwards of five feet. The cat is generally imagined to see best in the dark; and so peculiar is the structure of its eye that the pupil is capable of contraction and dilatation, in proportion to the degree of light affecting it. This circumstance gives it a most important advantage in exploring and seizing its prey. The character and manners of these animals in their state of domestication, are so generally known as almost to preclude the necessity of at all noticing them. Their expressions, whether of pain, anger, or love, are piercing, clamorous, and extremely harsh and hideous to the human ear. On the utterance of the sounds of distress by a single individual, multitudes will often assemble and appear to express their compassion by the most disgusting squalls and yellings. The result, however, frequently is, that the sufferer from disease or accident, from which the original call proceeded, is torn to pieces by its companions, who, not uncommonly, afterwards fall upon each other with the most savage fierceness, inflicting wounds and death without the least sensibility or discrimination. These sanguinary contests are uniformly carried on by night, and instances are related, on respectable authority, in which they have been conducted with the most destructive havoc. Cats are remarkably fond of certain perfumes, both vegetable or mineral; and, on this account are often very injurious to a garden or green-house, destroying the plants to which they are so partial. Cold and wet are avoided by these creatures with particular care, and their habits are peculiarly neat and cleanly, their fur being preserved by them, until in extreme age, from the slightest soil; and the most elegant and splendid furniture being in no danger from annoyance by them. The female is frequently obliged to conceal her young from the male, to preclude their being injured and even devoured by him; yet, in some instances, the female herself has been ascertained, in opposition to one

Felis *Leo: Lion. Lioness and Whelps.*

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of the most grand and prevailing instincts of nature, to eat them immediately on producing them; in general, however, the young are nursed with particular attention and affection, and the accommodation of the parent to the sportive propensities and varying gambols of the kitten, constitutes to the humane and even the philosophic mind an interesting spectacle. With respect to human beings, even those which have long protected and befriended it, the cat appears little susceptible of kind attachment on the change of habitations, quitting the family with which it had always lived, and returning to apartments to which, indeed, it had been long used, but where it could recognize no human friend. In this respect its manners exhibit a most disadvantageous contrast to those of the dog, which are in the highest degree social, affectionate, and grateful. The cat, however, often lives in habits of friendly intercourse with various animals in a state of similar domestication with itself, and to which in a state of nature it feels an almost unconquerable hostility. A French lady, of some eminence, by persevering attention and discipline, at length succeeded in accomplishing the extraordinary exploit of habituating her dog and cat, her bird and mouse, to take their food from the same plate. Cats are, though in general, by no means profound sleepers; often, and particularly in the depth of winter and on the approach of snow, can be roused from their sleep only with extreme difficulty; and will, on these occasions, exhale a fragrance similar to that of cloves. On rubbing the backs of these animals the electric spark is immediately felt, and the Leyden vial may, in frosty weather, be charged from this source by means of a connecting wire, and a glass-footed stool. Those who are pleased with contemplating the operations of animated surprise or curiosity, in any of the productions of nature, will be not a little entertained by the experiment of placing before a young cat, for the first time, a looking-glass: its delight at the figure thus exhibited is soon allayed by that impossibility of touching it which it finds to all its attempts: it at length looks behind the glass, and with great suddenness and vivacity shifts its examination both forwards and backwards, till at last it appears to observe the correspondence between the reflections on the mirror and the movements of its own foot gliding in various directions over the surface, and seems to have developed the mystery originally so perplexing.

F. lynx, or the lynx, is remarkable for its ears being long and erect, and tufted at the end with long black hairs. The skin of the male is more spotted than that of the female. In America and the North of Europe these animals are to be found in great abundance. They subsist by hunting squirrels, ermines, weasels, and other vermin; which they will pursue to the very tops of extremely high trees. They conceal themselves often among the branches, and watch with minute observation the approach of hares, deer, and other animals, which they seize with astonishing agility, and after having drank their blood reject the carcases almost entirely; devouring often, of a whole sheep, little more than the brain and liver. When attacked by a dog this animal places itself on its back, and seizing the throat of its adversary often actually suffocates it, or obliges it at least to retire from the conflict. The sight of the lynx is proverbially acute; its howling greatly resembles that of a wolf; in confinement it appears restless, malignant, and untameable, almost constantly uttering a snarling scream. The fur of these animals is an important article of commerce. The farther north they are taken the whiter and more valuable they are; and the winter furs are preferable to the summer ones. The length of a Russian lynx, from nose to tail, is four feet six inches. The lynx of the ancients appears to have been the creature of imagination. See Mammalia, Plate XIV. fig. 4.

From the lion to the common cat, through all the intermediate species of this abundant genus, a strong resemblance exists in form, internal structure, and habits; the shortness of the intestines, the sharpness and number of the teeth, the structure of the feet and claws are the same in all; they all feed on flesh, which they rather tear than masticate; they eat with slowness, and during the repast growl almost perpetually, as if apprehensive of its being intercepted from them; they all seize upon their prey by crafty approach and stealthy stratagem, rather than by open and intrepid attack. These are the animals from which man has most to apprehend, and which have hitherto, in every age, more or less, carried on hostilities against him. The power of some creatures is greater, but their tempers are less ferocious, and they exercise their strength not in acts of aggression but only in those of retaliation; and others, while they are inexpressibly more numerous, are, at the same time, destitute of any formid-

able powers of annoyance, and fly from the sight of man with the greatest rapidity and alarm. But between man and the feline tribe a contest for dominion is kept up over extensive regions of the globe, many of them highly ornamented and productive, and calculated to become the abodes of harmony and civilization.

FELLOWSHIP, or *Company*, in arithmetic, is when two or more join their stocks and trade together, dividing their gain or loss proportionably.

Fellowship is either with or without time. Questions without time, or in the single rule of fellowship, as it is frequently called, are wrought by the following proportion.

As the whole stock to the whole gain or loss, so is each man's particular stock to his particular share of gain or loss.

Suppose three partners, A, B, and C, make a joint stock in this manner: A puts in 24*l.*; B, 32*l.*; and C, 40*l.*; in all 96*l.*; with which they trade, and gain 12*l.*; required each man's true share of that gain? The first operation for A's part of the gain will stand thus:

£. £. £. £.
96 : 12 :: 24 : 3 = A's gain.
96 : 12 :: 32 : 4 = B's gain.
96 : 12 :: 40 : 5 = C's gain.

Proof, 3*l.* + 4*l.* + 5*l.* = 12*l.* the whole gain.

That is, if the total of all their particular gains amounts to the whole gain, the work is true; if not, some mistake has been committed.

FELLOWSHIP *with time*, usually called the *Double Rule of Fellowship*, because every man's money is to be considered with relation to the time of its continuance in the joint stock. It is worked thus: multiply each man's stock by the respective time he puts it in for, and add all the products, the total of which must be your first number through all the statings; the gain or loss the second, as before, and each man's particular stock, multiplied by its time, the third.

Note, the times, and sums, (if not so given) must be reduced into one denomination, *i. e.* all years, all months, all weeks, or all days, &c.

Ex. Three merchants, A, B, and C, enter into partnership thus: A puts into the stock 65*l.* for eight months; B puts in 78*l.* for twelve months; and C puts in 84*l.* for six months: with this joint stock they traffic, and gain 166*l.* 12*s.*: it is required to find each man's share of the gain proportionable to his stock and time of employing it.

£.
1. A's stock, 65 × 8 months, the time it was employed = 520
2. B's stock, 78 × 12 months, the time it was employed = 936
3. C's stock, 84 × 6 months, the time it was employed = 504

The sum of all those products is 1960

Then, the several proportions will stand thus:

£. s. d.
1960 : 166,6 :: 520 : 44, 2 = 44 .. 4 .. 0 for A's share.
1960 : 166,6 :: 936 : 79,56 = 79 .. 11 .. $2\frac{1}{2}$ for B's share.
1960 : 166,6 :: 504 : 42,84 = 42 .. 16 .. $9\frac{1}{2}$ for C's share.

The whole gain = £166 .. 12 .. 0

FELO *de se*, in law, one who is felon of himself; *i. e.* being of sound memory, and of the age of discretion, or 14 years, kills himself. All his chattels, real and personal, are forfeited to the crown, when it is found by the Coroner that he is *felo de se;* a will, therefore, made by him, is void as to his personal estate, but not as to his land or real estate; nor is his wife barred of her dower. If a man and his wife are possessed of a term, and the man commit suicide, the term is forfeited, and the wife shall not have it by survivorship. The Coroner must find the fact upon an inquest, on view of the body, in order to vest the goods in the King.

This law is, in our opinion, hard and unjust: if a man is determined to commit suicide, human laws can have no hold upon him; and the cruelty of punishing the descendant for the act of the father, is so generally acknowledged, that where the party has any thing to forfeit, it is either found lunacy, or the crown gives up the forfeiture

upon petition. The further punishment of a *felo de se* is, to be buried in a highway, and a stake run through the body. This being never practised but upon the poor, is become merely an odious distinction. The law of the Romans seems more reasonable, which only forfeited the estate where the party killed himself to avoid punishment for a crime.

FELONY, in the general acceptation of law, comprises every species of crime which occasions, at common law, the forfeiture of land or goods. The punishment of a person for felony, by our ancient books, is, 1st, to lose his life; 2dly, to lose his blood, as to his ancestry, and so to have neither heir nor posterity; 3dly, to lose his goods; 4thly, to lose his lands, and the King shall have year, day, and waste, to the intent that his wife and children be cast out of the house, his house pulled down, and all that he had for his comfort and delight destroyed. A felony, by statute, incidentally implies, that the offender shall be subject to the like attainder and forfeiture, &c., as is incident to a felon at common law. This is now the punishment in case of a capital felony only; but for some offences benefit of clergy is allowed, when the offence is punished only with transportation, imprisonment, &c. which are called felonies with benefit of clergy; but the goods and estate of the felon are forfeited as in cases of capital felony.

FELT, in commerce, a sort of stuff, deriving all its consistence merely from being fulled, or wrought with lees and size, without either spinning or weaving. Felt is made either of wool alone, or of wool and hair.

FELTING, the method of working up hair or wool into a species of cloth, independently of either spinning or weaving. A hatter separates the hairs from each other by striking the wool with the string of his bow, causing them to spring up in the air, which fall on the table in every direction, which is covered by the workman with cloth, pressing it with his hands, and moving the hairs backwards and forwards in different directions. In this manner the hairs are brought against each other, and their points of contact considerably multiplied, and the agitation gives each hair a progressive motion towards the root, in consequence of which the hairs become twisted together. As the mass becomes compact, the pressure should be increased, in order to keep up the progressive motion and twisting of the hairs, which is then performed with greater difficulty. The hair intended for the manufacturing of hats is always cut off with a sharp instrument, and not pulled out by the roots, because the bulb of the hair, which would come out with it in the latter case, would render the end which was fixed in the skin very obtuse, and nearly destroy its disposition to unite with the adjacent hairs. The hairs should not be straight like needles, for then there would be no compactness in the stuff. The fibres of wool having naturally a crooked form, that substance is well adapted to the operation of felting. The hair of beavers, rabbits, hares, &c., being straight, cannot be used in felting, till it has been prepared for the purpose.

FEMME *covert*, in law, a married woman, so called from being under the cover, protection, and influence of her husband.

FEMME *sole*, in law, a single or unmarried woman.

FEMME *sole trader*, a married woman who, by the custom of London, trades on her own account, independent of her husband; who, by the same custom, is answerable for her own debts, and may be made a bankrupt.

FEMININE, in grammar, one of the genders of nouns. As there are but two sexes, so, in fact, there can be but two genders.

The feminine gender serves to intimate that the noun belongs to the female. In Latin, the feminine gender is most commonly distinguished by the article *hæc*, as it is in the Greek by the article ἡ. In the French, the article *la* commonly denotes this gender; but we have no such distinction by articles in the English language.

FEMINEUS *flos*, a female flower. By this name Linnæus denominates a flower which is furnished with the pistillum, or female organ of generation, but wants the stamina or male organ. Female flowers may be produced apart from the male, either on the same root, or on distinct plants. The birch and mulberry are examples of the first case; willow and poplar of the second. Male and female flowers separated on the same plant, constitute the class Monoecia of Linnæus; separated on distinct roots, the class Dioecia.

FEN, a place overflowed with water, or abounding with bogs; the term is also applied to such boggy lands as are naturally disposed to produce coarse vegetables from the retention of water. In many parts of the kingdom since the introduction of a

laudable spirit of improvement in agriculture, much valuable land has been redeemed both in England and Ireland from bogs and fens. There are, however, vast tracts of land of this kind still in different districts, in Lincolnshire, Lancashire, Cambridgeshire, and the West of England. In short, there are but few counties without them, which, by proper inclosing, draining, pairing and burning, and the growth of suitable crops, might be rendered highly valuable; but which at present afford little except reeds, sedge, or rushes and coarse grass.

FENCE, in country affairs, a hedge, wall, ditch, bank, or other inclosure, made around gardens, woods, corn-fields, &c. See AGRICULTURE.

FENCING, is the manner of attacking an adversary with the sword, and defending the person from his thrusts. It is necessary in acquiring this difficult art to use foils, or small thin swords, which being blunted at the points, and bending readily, prevents accidental wounds. The gladiators, who were compelled to sacrifice their lives for the amusement of the Romans, received instructions in the use of the sword in order to lengthen the diversion of their cruel masters, who were fearful that sudden rage might otherwise prompt an abrupt termination of the combat. Kennet says, "Before the combatants fell to it in earnest they tried their skill against one another with more harmless weapons, as the rudes, and the spears without heads, the blunted swords, the foils, and such like." To this Cicero admirably alludes, "If in the mortal combats of the gladiators, where the victory is decided by arms, before they actually engage, there are several flourishes given more for a shew of art than a design of hurting; how much more proper would this look in the contention of an orator."

Fencing was indispensible to almost all ranks of people, long after armies had ceased to use swords in the field of battle, through the absurd fashion of wearing side-arms; when men of turbulent dispositions might have immediate recourse to weapons it became necessary for the peaceable citizen to learn the best mode of defence, that he might not perish for an offence which would end at present in altercation. During the long period this supposed ornament of the person was worn, numerous masters brought the art of using it to great perfection; but the French appear to have excelled every other nation in fencing, which may be attributed in a great measure to the physical properties of their bodies. Their teachers and their imitators have, therefore, been loud in its praises, asserting that the art should be taught in every polite academy, that the figure may be formed into complete grace by the active movements of the limbs and body in every possible position.

The professors divide fencing into two parts, which they distinguish from each other by terming the first simple, and the second compound; the first they perform instantaneously and actively on the same line, either on the offensive or defensive. The principle on which they act, in this instance, is to push or make passes in any direction, to strike the least guarded part of the adversary, at the same time endeavouring to parry his thrusts.

Compound fencing consists of every description of feint appeals, entangling of foils, slashing, half thrusts, &c. contrived to distract the attention of the enemy, and thus suddenly and unexpectedly to reach that spot which he skilfully defends in simple fencing; but the utmost care must be used to push at the proper moment when parrying.

FEND, in the sea language, imports the same as defend: thus, fending the boat, is saving it from being dashed to pieces against the rocks, shore, ship's sides. And hence

FENDERS are pieces of old hawsers, cable-ropes, or billets of wood, hung over the ship's sides, to keep other ships from rubbing against and injuring her.

FENNEL. See ANETHUM.

FEODAL, or FEUDAL *system*. This system originated from an assumed right obtained by conquest. When the Roman empire began to decline and that government became too feeble to support its most distant possessions, the Celtic nations taking advantage of the reduced state of their various military posts marched in such numbers through the southern parts of Europe that opposition was deemed vain, and these northern hordes of Lombards, Franks, Huns, Goths, and Vandals conquered them without difficulty. Acting upon their previous policy, they immediately introduced the military practice they had adopted towards their enemies, which was the general confiscation of land to the use of the most powerful chiefs; those for obvious motives distributed portions to enterprising subordinates, and even to the common soldier who had earned laurels in their predatory wars. The grants thus made were conditional, and called feoda, feuds, fiefs, or fees, which words

imply the receipt of a reward given for past, and to secure future services; it might, indeed, be considered an actual sale of the person for military purposes, and the bargain became void by the land reverting to the first possessor, if the party refused to march, or fled from his chief in battle; but this, or similard ishonourable conduct, was further guarded against by an oath of fealty.

Viewing this system only in the light of a firm bond of union subsisting between barbarians, it must be admitted that a better could not well be devised, as the chief held officers of trust to his interest, by combining it with their own, and the vassals of the latter had an equally just reason to rely on the fidelity of others, who held land under their fee. The necessity of preserving their conquests rather than any generous principle towards each other, evidently dictated the feodal system, and it was rendered almost impossible by this means that insurrections of the conquered nations should succeed, or that foreign armies could have the least chance of success when opposed to a prince at the head of his feudatories; hence the nations thus constituted, became powerful in the aggregate, and every individual, oppressed by his lord, had a common claim for redress from the lowest feudatory in gradation to the chief, otherwise the whole fabric must have fallen into ruin. Exclusive of the feodal grants, there were others, termed allodial, which, though not free from military service, were given upon more liberal principles than the former, by those all free men had a right to dispose of their territory. In order to secure the prompt assistance of this description of persons, they were invited by a sort of honourable liberty to defend the country in battle, which was denied to the slaves, who were compelled to follow what was then thought the inglorious arts of peace. These allodial proprietors composed a national militia, and had the privilege of possessing moveables and money, a circumstance which compelled them to take the field at the requisition of the sovereign, when the country was in danger; but they were exempt from interfering in the disputes of feudal lords, and this exemption operated at length in subverting all their advantages, being independent of either party, both the lords and their vassals viewed them with jealousy, and each presuming upon their inability to protect themselves, injured and insulted them, well knowing that as they were scattered at remote distances throughout the country, and forbidden by law from committing hostilities, they had nothing to apprehend from their resentment. The folly and barbarity of this conduct can only be accounted for by the consummate ignorance and brutality of all classes of men, who inured to rapine, injustice, and bloodshed, paid homage to power alone, rejecting the sacred claims of property, and despising all other merit besides that of courage; the necessary consequence was, that the prince courted the most valiant and powerful of his chiefs, and neglected the allodial proprietors in proportion, because he could derive no advantage from them; they in return became completely disgusted with their situation, and wearied by the neglect of the monarch, the destruction of their property without hope of redress, and continual insults, they finally determined to solicit common protection, by resigning their lands to those lords who would deign to return them as feodal tenures; such was the effect of this cruel system of plunder which made fiefs universal.

The advocates for a state of society so constituted, urge with some degree of justice, that a feudal lord, surrounded by his vassals, resembled the father of a numerous family, each reciprocally benefiting the other, and this was certainly the fact in some particular cases, when the lord happened to be of a benevolent disposition and dispensed his favours liberally, such a man deserved, and perhaps received, gratitude equivalent, and hence originated feodal incidents. The expectants of fiefs, before they were hereditary, and the heirs afterwards, educated under his immediate inspection, were attached to him as if they had been his own offspring, and received their lands when of age, with a determination to defend his interest to the utmost of their ability, in return for his careful and paternal wardship, which they further demonstrated by a grateful present on taking possession. The former was called the incident of wardship, and the latter the incident of relief.

There was also an incident of marriage, which was founded upon the same principle as that of reliefs; this operated to prevent alliances with the family or vassals of inimical chiefs, and induced the lord to find such persons for his wards as would promote his own future advantage.

The incident of aid, is explained by the term; in this case all vassals were com-

pelled to assist their lord, whether his misfortunes were caused by extravagance, or losses by war.

The incident of escheat has been already noticed, and took place upon the default of the vassal in his customary service.

It will be observed, that this system depended solely on high conceptions of honour, while the chief made it apparent that he gloried in the fidelity and happiness of his vassals, they felt equal pride in supporting his splendor, and in endeavouring to elevate his consequence beyond that of his neighbour; but when the lord ceased to value the lives and property of his vassals, and made both subservient to purposes of mere ambition and avarice, the feodal system began to tremble to its base; wardship instead of being as before mutually advantageous, was then rendered the means of filling the coffers of the lord, and the ward was sometimes ransomed to prevent worse consequences: the result is obvious, the vassals received their inheritance almost exhausted, and viewed the incidents as so many lawless exactions, by which they might be stripped of large sums in reliefs, married to whom the lord pleased, purchase the freedom of marrying, or lose his land if he did neither. The aid which had been given as a tribute of gratitude on the marriage of the eldest daughter of the chief; when his heir received the distinction of knighthood; or when the lord was made prisoner, was demanded as a tax on the most trivial pretences; nor were escheats confined to real causes of forfeiture; on the contrary, every venial offence, entirely out of contemplation in the original compact, was converted into a crime, and pronounced just reasons for seizure. In this wretched situation, disheartened by oppression, and unable to resist without virtually resigning the whole of their property, by that single act the vassals shrunk from the firm attitude they had assumed in battle, when fighting by the side of a generous chief into the inertness of slaves, who, burning with secret hatred, often committed military errors purposely, equally involving their sovereigns and their own safety; from this cause knights' service had its origin. See KNIGHT *service.*

FEOFFMENT, in law, may be defined to be the gift of any corporeal purditament to another. He that so gives or enfeoffs is called the feoffer; and the person enfeoffed is denominated the feoffee. But by the mere words of the deed the feoffment is by no means perfected. There remains a very material ceremony to be performed, called livery of seisin, without which the feoffee hath but a mere estate at will. Livery in deed is the actual tradition of the land, and is made either by the delivery of a branch of a tree or a turf of the land, or some other thing, in the name of all the lands and tenements contained in the deed; and it may be made by words only, without the delivery of any thing, as if the feoffer upon the land, or at the door of the house, says to the feoffee, "I am content that you should enjoy this land according to the deed." This is a good livery to pass the freehold. The livery within view, or the livery in law, is when the feoffer is not actually on the land, or in the house, but being in sight of it, says to the feoffee, "I give you yonder house, or land, go and enter into the same, and take possession of it accordingly." This livery in law cannot be given or received by an attorney, as livery in deed may; but only by the parties themselves. A feoffment cannot be made of a thing of which livery cannot be given, as of incorporeal inheritances, such as rent, advowson, common, &c. Though it be an advowson, &c. in gross. A man may either give or receive livery in deed, by letter of attorney; for since a contract is no more than the consent of a man's mind to a thing, where that consent or concurrence appears, it were most unreasonable to oblige each person to be present at the execution of the contract, since it may as well be performed by any other person delegated for that purpose, by the parties to the contract.

FERÆ, in natural history, an order of quadrupeds, of which the distinguishing characters are, fore-teeth conic, usually six in each jaw; tusks longer; grinders with conic projections; feet with claws; claws subulate; food carcases and preying on other animals: this order comprehends the following genera:

Canis,	Phoca,
Didelphis,	Sorex,
Erinaceus,	Talpa,
Felis,	Viverra,
Mustela,	Ursus,

which see.

FERÆ *naturæ.* Animals feræ naturæ, of a wild nature, are those in which a man hath not an absolute, but only a qualified and limited property, which sometimes subsists, and at other times doth not sub-

sist; and this qualified property is obtained either by the art and industry of man, or the impotence of the animals themselves, or by special privilege, as in case of game.

A qualified property may subsist in animals *feræ naturæ* by the art and industry of man, either by his reclaiming and making them tame, or by so confining them, that they cannot escape and use their natural liberty; such as deer in a park, hares or conies in an enclosed warren, doves in a dove-house, pheasants or partridges in a mew, hawks that are fed and commanded by the owner, and fish in a private pond or in trunks. These are no longer the property of a man than while they continue in his keeping, or actual possession; but if at any time they regain their natural liberty, his property instantly ceases; unless they have *animum revertendi*, which is only to be known by their usual custom of returning. Larceny cannot be committed of things *feræ naturæ* while at their natural liberty; but if they are made fit for food, and reduced to tameness, and known by the taker to be so, it may be larceny to take them. 1 Haw. 94. See GAME.

FERGUSON (JAMES), an eminent experimental philosopher, mechanic, and astronomer, was born in Bamffshire, in Scotland, 1710, of very poor parents. At the very earliest age his extraordinary genius began to unfold itself. He first learned to read, by overhearing his father teach his elder brother; and he had made this acquisition before any one suspected it. He soon discovered a peculiar taste for mechanics, which first arose on seeing his father use a lever. He pursued this study a considerable length, while he was yet very young; and made a watch in wood-work, from having once seen one. As he had no instructor, nor any help from books, every thing he learned had all the merit of an original discovery; and such, with inexpressible joy, he believed it to be.

As soon as his age would permit, he went to service; in which he met with hardships, which rendered his constitution feeble through life. While he was servant to a farmer, (whose goodness he acknowledges in the modest and humble account of himself which he prefixed to one of his publications), he contemplated and learned to know the stars, while he tended the sheep; and began the study of astronomy, by laying down, from his own observations only, a celestial globe. His kind master observing these marks of his ingenuity, procured him the countenance and assistance of some neighbouring gentlemen. By their help and instructions he went on gaining farther knowledge, having by their means been taught arithmetic, with some algebra, and practical geometry. He had got some notion of drawing, and being sent to Edinburgh, he there began to take portraits in miniature, at a small price; an employment by which he supported himself and family for several years, both in Scotland and England, while he was pursuing more serious studies. In London he first published some curious astronomical tables and calculations; and afterwards gave public lectures in experimental philosophy, both in London, and most of the country towns in England, with the highest marks of general approbation. He was elected a Fellow of the Royal Society, and was excused the payment of the admission fee, and the usual annual contributions. He enjoyed from the King a pension of fifty pounds a year, besides other occasional presents, which he privately accepted and received from different quarters, till the time of his death; by which, and the fruits of his own labours, he left behind him a sum to the amount of about six thousand pounds, instead of which all his friends had always entertained an idea of his great poverty. He died in 1776, at 66 years of age, though he had the appearance of many more years.

Mr. Ferguson must be allowed to have been a very uncommon genius, especially in mechanical contrivances and executions; for he executed many machines himself in a very neat manner. He had also a good taste in astronomy, and natural and experimental philosophy, and was possessed of a happy manner of explaining himself in an easy, clear, and familiar way. His general mathematical knowledge, however, was little or nothing. Of algebra he understood but scarcely more than the notation; and he has often told Dr. Hutton, he could never demonstrate one proposition in Euclid's Elements; his constant method being to satisfy himself as to the truth of any problem with a measurement by scale and compasses. He was a man of a very clear judgment in any thing he professed, and of unwearied application to study; benevolent, meek, and innocent in his manners as a child: humble, courteous, and communicative: instead of pedantry, philosophy

seemed to produce in him only diffidence and urbanity.

The list of Mr. Ferguson's public works is as follows: 1. Astronomical Tables and Precepts for calculating the true times of new and full Moon, &c., 1763. 2. Tables and Tracts, relative to several Arts and Sciences, 1767. 3. An easy Introduction to Astronomy for young Ladies and Gentlemen, 2d edit. 1769. 4. Astronomy explained upon Sir Isaac Newton's principles, 5th edit. 1772. 5. Lectures on select Subjects in Mechanics, Hydrostatics, Pneumatics, and Optics, 4th edit. 1772. 6. Select mechanical Exercises; with a short Account of the Life of the Author by himself, 1773. 7. The Art of Drawing in perspective made easy, 1775. 8. An Introduction to Electricity, 1775. 9. Two Letters to the Rev. Mr. John Kennedy, 1775. 10. A third Letter to the Rev. Mr. John Kennedy, 1775.

FERMENTATION. The word fermentation, in general, is used to denote that change in the principles of organic bodies which begins to take place spontaneously as soon as their vital functions have ceased, and by them are at length reduced to their first principles. This has been distinguished into three stages, the vinous or spirituous, the acid or acetous, and the putrid fermentation. It is acertained almost beyond doubt, that the vinous fermentation takes place only in such bodies as contain saccharine juices. In this the most remarkable product is a volatile, colourless, slight inflammable fluid, which mixes with water in all proportions, and is called alcohol, which see. The acetous fermentation is distinguished by the product known by the name of vinegar, which is the least destructible of the vegetable acids. It does not appear, however, that fermentation is absolutely necessary for the production of this acid, as there are many other chemical processes by which it may be obtained or produced. In the putrid fermentation, bodies appear to be reduced into their most simple parts. Ammonia is the product which has been remarked as the chief of this process, and is no doubt produced by the combination of the hydrogen and nitrogen gases, which are disengaged together. See AMMONIA.

The acetous, like the vinous fermentation, is confined to vegetable substances; but the putrefactive process is most eminently perceived in animal bodies. These either putrefy immediately; or if the putrefaction be preceded by either of the other stages, their duration is too short to be perceived. It is considered as an established fact, that the three stages of fermentation always follow in the same order in such bodies, as are susceptible of them all; the vinous coming first, which is followed by the acetous and the putrefactive processes.

The spontaneous decomposition of bodies is retarded by extreme cold, by sudden drying of the parts, or by preservation in closed vessels. The two first circumstances necessarily retard the chemical effects by depriving the parts of that fluidity which is almost indispensably necessary in chemical processes. It will easily be understood that the third condition will retard the spontaneous decomposition of bodies; when it is considered that the atmosphere itself is the solvent, or at least the receptacle of many of the component parts of bodies, with which it is disposed to unite. In well closed vessels the parts of organized bodies, which are disposed to fly off in the elastic state, are prevented from escaping; and such parts as might form new combinations, by absorbing either the contents or the component parts of the atmosphere, are prevented for want of a free communication. The three conditions for the accomplishment of fermentation are, therefore, fluidity or moisture, moderate heat, or a due temperature, and the access of air; the fermentation will likewise be modified according to the various component parts of bodies.

In describing the vinous decomposition of vegetables, it will be of advantage to attend to that of mere sugar and water; the phenomena in these being more distinct, because less modified by foreign admixture. If a considerable quantity of water, holding in solution about one third of its weight of sugar be exposed to the air, at the temperature of about seventy degrees, after the addition of a small quantity of yeast, it soon undergoes a remarkable change. In the course of a few hours the fluid becomes turbid and frothy; oxygen is absorbed, bubbles of carbonic acid gas are disengaged, which rise to the surface and break. The disengagement becomes more and more abundant; mucilage is separated, part of which subsides to the bottom; and part being expanded into froth by the elastic fluid forms yeast. During the course of several days, these effects gradually come to their height and

diminish again; after which they proceed very slowly, but are long before they entirely cease. The fermented liquor has then no longer the sweet taste it had before, but becomes brisk and lively, with a pungent spirituous flavour. Its specific gravity is also considerably less than before; and when exposed to distillation it affords a light inflammable spirit. The quantity of this spirit or alcohol, any fermented liquor will produce, is thought to follow some proportion of the change its specific gravity undergoes in fermentation; but the truth of this has not been clearly ascertained. Wine, cyder, and beer, are well known liquors of this kind.

It is usual to put fermented liquors into casks before the vinous fermentation is completely ended; and in these closed vessels, the change goes on for many months. But if the fermentative process be suffered to proceed in open vessels, more especially if the temperature be raised to ninety degrees, the acetous fermentation comes on. In this a still greater portion of oxygen from the air is gradually absorbed; and this more especially as the surfaces of the liquor are oftener changed by lading it from one vessel to another. The usual method of doing this consists in exposing the fermented liquor to the air, in casks placed so that the sun may shine on them; which seems to be of advantage by raising the temperature of the liquor. By this absorption of oxygen the inflammable substance becomes converted into an acid. If the liquor be then exposed to distillation, vinegar comes over instead of alcohol or spirit.

When the spontaneous decomposition is suffered to proceed beyond the acetous process, the vinegar gradually becomes viscid and foul; a gas is emitted with an offensive smell; ammonia flies off, an earthy sediment is deposited, and the remaining liquid, if any, is mere water. This is the putrefactive process.

Though fermentation is much better understood at present, in consequence of modern researches into the nature of the gases, than it formerly was; it still remains an interesting object of research. It is not clearly ascertained what the yeast or fermented matter performs in this operation. It seems probable that the fermentative process in considerable masses would be carried on in succession from the surface downwards; and would perhaps be completed in one part of the fluid before it was perfectly begun in another part, if the yeast, which is already in a state of fermentation, did not occasion the process to begin in every part of the fluid at once. Experiments yet remain to be made towards ascertaining the arrangements and quantity of the component parts of alcohol. It appears that hydrogen in combination with carbon and water, in certain proportions, form this compound; that a greater proportion of oxygen converts it into vinegar; and that in the putrefactive process the hydrogen, carbon, and oxygen, are separated from each other, and fly off in the elastic state.

In the fermentation of wine, the tartar, which probably existed for the most part already formed in the juice of the grape, is separated and exhibits the properties which are described in treating of that substance.

The fermentation of bread, by leaven, is thought to be of a different nature from the vinous fermentation. In this, the mucilage of the corn is not previously brought into the saccharine state. It quickly becomes sour, if the process be not stopped by baking; in which particular the fermentation seems to be of the acetous kind. The developement of carbonic acid, divides the dough into thin parts, which are more effectually and better baked than they could have been in the solid consistent mass. When bread is fermented by means of yeast, the process seems to be of a saccharine or vinous nature. A very minute proportion of alum, renders bread whiter, and its pores more small and numerous, but how it acts has not been ascertained. It does not seem either from its quantity or quality to be unwholesome.

FERN. See Filices. Fern is very common in dry and barren places. It is one of the worst of weeds for lands, and very hard to destroy where it has any thing of a deep soil to root in. In some grounds the roots of it are found to the depth of eight feet. One of the most effectual ways to destroy it is often mowing the grass, and if the field be ploughed up, plentiful dunging thereof is very good: but a most certain remedy for it is urine. However, fern, cut while the sap is in it, and left to rot upon the ground, is a very great improver of land; for if burnt, when so cut, its ashes will yield double the quantity of alkali that any other vegetable can do.

In several places, in the north, the inhabitants mow it green, and burning it to ashes,

make those ashes up into balls with a little water, which they dry in the sun, and make use of them to wash their linen with, looking upon it to be nearly as good as soap for that purpose.

FERONIA, in botany, a genus of the Decandria Monogynia class and order. Calyx five-parted; petals five; berry globular, covered with a hard, rough, woody shell, one-celled; seeds numerous. There is but one species; *viz.* F. elephantum, elephant apple-tree, found in the East Indies. See Linn. Trans. vol. v.

FERRARIA, in botany, so named in honour of John Baptist Ferrarius, a genus of the Gynandria Trigynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: one-styled; spathes one-flowered; petals six, waved and curled; stigmas cowled; capsule three-celled, inferior. There are two species.

FERRET. See MUSTELA.

FERRETS, among glass-makers, the iron with which the workmen try the melted metal, to see if it be fit to work.

FERREOLA, in botany, a genus of the Dioecia Hexandria class and order. Essential character: calyx one-leafed, three-cleft; corolla one-petalled, three-cleft: male, filaments six; inserted into a semi-globose receptacle: female, germ oval; berry round, smooth, two-seeded. There is but one species; *viz.* F. buxifolia.

FERRUGINOUS, any thing partaking of iron, or that contains particles of that metal. See IRON. It is particularly applied to certain mineral springs, whose waters are impregnated with the particles of iron, generally termed chalybeates.

FERRY, in law, is a liberty by prescription, or the King's grant, to have a boat for passage upon a river for carriage of horses and men for reasonable toll. Owner of a ferry cannot suppress that ferry, and put up a bridge in its place, without a licence. And if a ferry be granted at this day, he who accepts such grant is bound to keep a boat for the public good.

FERULA, in botany, English *fennel-giant*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: fruit oval, plane, compressed, with three streaks on each side. There are nine species.

FESSE, in heraldry, one of the nine honourable ordinaries, consisting of a line drawn directly across the shield, from side to side, and containing the third part of it, between the honour-point and the nombril. It represents a broad girdle or belt of honour, which knights at arms were anciently girded with.

FESSE *point* is the exact centre of the escutcheon.

FESSE *ways*, or *in* FESSE, denotes any thing borne after the manner of a fesse: that is, in a rank across the middle of the shield.

FESSE, *party per*, implies a parting across the middle of the shield, from side to side, through the fesse point.

FESTINO, in logic, the third mood of the second figure of syllogism, the first proposition whereof is an universal negative, the second a particular affirmative, and the third a particular negative: as in the following example:

FES No bad man can be happy,
TI Some rich men are bad men:
NO *Ergo*, some rich men are not happy.

FESTUCA, in botany, English *fescue grass*, a genus of the Triandria Digynia class and order. Natural order of Graminæ, or grasses. Essential character: calyx two-valved; spikelet oblong, roundish, with acuminate glumes. There are twenty-six species.

FEUDS. Estates in lands were originally at will, and then they were called *munera*; afterwards they were for life, and then they were called *beneficia*; and for that reason the livings of clergymen are so called at this day; afterwards they were made hereditary, when they were called *feoda*, and in our law fee simple.

FEVER. See MEDICINE.

FEVERFEW. See MATRICARIA.

FEUILLEA, in botany, so called in honour of Louis Feuillee, a genus of the Dioecia Pentandria class and order. Natural order of Cucurbitaceæ. Essential character: male, calyx five-cleft; corolla five-cleft; stamens five; nectary five converging filaments: female, calyx five-cleft; styles three; pome hard, three-celled, corticose. There are two species.

FIBER, the beaver, in zoology, is made, by Linnæus, a species of castor. See CASTOR.

FIBRE, in anatomy, a perfectly simple body, or at least as simple as any thing in the human structure; being fine and slender like a thread, and serving to form other parts. Hence some fibres are hard, as the bony ones; and others soft, as those destined for the formation of all the other parts. See ANATOMY.

FIBRES, *flexible union of.* The strength

of cordage, and of other substances which are employed in the communication of motion, where flexibility is required, as well as the utility of other flexible materials, depends principally upon the lateral adhesion produced by twisting, or by the intermixture of fibres. The mechanism of simple spinning is easily understood; care is taken, where the hand is employed to intermix the fibres sufficiently; and to engage their extremities as much as possible in the centre; for if any fibre were wholly external to the rest, it could not be retained in the yarn. See ROPE, SPINNING, &c.

FIBRIN. If a quantity of blood, newly drawn from an animal, be allowed to remain at rest for some time, a thick red clot gradually forms in it, and subsides. Separate this clot from the rest of the blood, put it into a linen cloth, and wash it repeatedly in water till it ceases to give out any colour or taste to the liquid; the substance which remains after this process is denominated fibrin. It has been long known to physicians under the name of the fibrous part of the blood; but has not till lately been accurately described. It may be procured also from the muscles of animals.

Fibrin is of a white colour, has no taste nor smell, and is not soluble in water nor in alcohol. It undergoes no change, though kept exposed to the action of the air; neither does it alter speedily, though kept covered with water. When exposed to heat, it contracts very suddenly, and moves like a bit of horn, exhaling at the same time the smell of burning feathers. In a stronger heat it melts. When exposed to destructive distillation, it yields water, carbonate of ammonia, a thick, heavy, fetid oil, traces of acetic acid, carbonic acid, and carbureted hydrogen gas. The charcoal, as Hatchett ascertained, is more copious than that left by gelatine or albumen. It is very difficult to incinerate, owing to the presence of phosphate of soda, and some phosphate of lime, which form a glassy coat on the surface. A considerable proportion of carbonate of lime also remains after the incineration of the charcoal.

Acids dissolve fibrin with considerable facility. Sulphuric acid gives it a deep brown colour; charcoal is precipitated, and acetic acid formed. Muriatic acid dissolves it, and forms with it a green-coloured jelly. The acetic, citric, oxalic, and tartaric acids, also dissolve it by the assistance of heat; and the solutions, when concentrated, assume the appearance of jelly. Alkalies precipitate the fibrin from acids in flakes, soluble in hot water, and resembling gelatine in its properties.

From the recent experiments of Fourcroy and Vauquelin, on the muscular fibres of animals, there can be little doubt that fibrin, when treated with hot nitric acid, undergoes a suit of changes. 1. It is converted into a yellow matter, which still possesses the fibrous texture of fibrin. It has the property of converting vegetable blues to red, has a bitter taste, is but little soluble in water, and is insoluble in alcohol. It combines with alkalies, decomposes their carbonates, unites to oils, and gives them rancidity and acid properties. To this substance, Fourcroy and Vauquelin have given the name of yellow acid. 2. By the farther action of the nitric acid, this yellow matter becomes more soluble, acquires a reddish tinge, and seems to become soluble in alcohol. 3. The last state into which it is brought by nitric acid seems to be that species of bitter principle which crystallizes and detonates when combined with ammonia.

The alkalies, when diluted, have but little effect upon fibrin; but when concentrated potash or soda is boiled upon it, a complete solution is obtained of a deep brown colour, possessing the properties of soap. During the solution ammonia is disengaged. When the solution is saturated with muriatic acid, a precipitate is obtained similar to that from animal soap, except that it sooner becomes hard and soapy when exposed to the air.

The earths, as far as is known, have little or no action on fibrin. Neither has the action of the metallic oxides and salts been examined. Fibrin is insoluble in alcohol, ether, and oils. The effect of other reagents on it has not been examined.

FIBROLITE, a species of the topaz family, first observed by Bournon in the matrix of the imperfect corundum. Colour white, or dirty grey; hardness rather greater than that of quartz; specific gravity 3.214; texture fibrous; cross fracture compact; internal lustre glossy; infusible by the blow-pipe; usually in shapeless fragments. Bournon observed one specimen crystallized, in a rhomboidal prism; the angles of whose faces where 80° and 100°. It is composed, according to Chenevix, of 52.25 alumina, 38 00 silica, and 3.75 a trace of iron and loss.

FIBULA, in anatomy, a long bone placed on the outside of the leg, opposite to the external angle of the tibia. See ANATOMY.

FICTION *of law* is allowed of in several cases: but it must be framed according to the rules of law; and there ought to be equity and possibility in every legal fiction. Fictions were invented to avoid inconvenience; and it is a maxim invariably observed, that no fiction shall extend to work an injury; its proper operation being to prevent a mischief, or remedy an inconvenience, that might result from the general rule of law.

FICUS, in botany, English *fig-tree*, a genus of the Polygamia Trioecia class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: receptacle common, turbinate, fleshy, converging, concealing the floscules, either on the same or a distinct individual: male calyx three-parted; corolla none; stamens three: female calyx five-parted; corolla none; pistil one; seed one. There are fifty-six species.

The fig is a striking instance of that contrivance which nature occasionally employs for the continuation of her species. We were for a long time unacquainted with the manner in which these plants were propagated: in other kinds it is the flower which contains the embryo of the fruit; in this, on the contrary, it is the fruit which incloses and conceals the flower. The mode in which the fig-trees are made to produce their fruit, is called caprification. Among the several species of this genus which have been enumerated by botanists, the common fig is by far the most useful, and is cultivated in many parts of Europe for the excellence of its fruit. The wild as well as the cultivated kind is supposed to have been originally brought from Asia, from whence they have been spread over the southern parts of Europe, and are now to be met with in Languedoc, in Provence, in Spain, in Italy, &c. not to mention those of England, which are merely raised for the table, and not cultivated, like those abroad, for commercial purposes.

Where the climate is congenial to their nature, figs seem to thrive in almost any soil; but Duhamel observes, that they produce the most succulent fruit when growing among the rocks. They require a certain degree of heat: for although this gentleman saw figs of a monstrous size at Brest, yet they rarely became perfectly ripe for want of the necessary warmth. The trees are generally raised from slips or layers, which readily strike root; and the manner which is often practised to effect this is simple enough, though rather singular. When it is proposed to propagate the plant by layers, a branch of the tree is made to pass through a tin funnel, or a wicker basket, filled with earth, into which the branch will soon shoot several fibres; it should then be cut asunder below the basket, which should afterwards be placed in the earth. When it is desired to raise fig-trees that will bear fruit the next year, the finest branches of an old tree are laid in the earth, and one of a moderate size is caused to pass through a box, after being stripped of its bark for about a finger's breadth between two knots. The part so stripped is then placed about four fingers' breadth above the bottom of the box, and covered with earth. In due time the branch will shoot out several roots from the wounded part, after which it is separated from the stem by cutting it off below the box.

Several of the cultivated species, according to Duhamel, require only the ordinary attention paid to fruit-trees to make them ripen their fruit; but in the Archipelago, and in Malta, there are figs, both wild and domestic, that require a very singular mode of treatment to make them bring their fruit to perfection; the assistance we here allude to is named caprification, and is a phenomenon highly deserving our attention. Only two kinds of figs are cultivated in the Archipelago, the domestic and the wild; from the former they gather that fruit which can only be brought to perfection by the assistance of the latter, or wild fig, which has been named caprificus, and in the country ornos. This tree bears successively, in the same year, three sorts of fruit, to which the natives of the Archipelago have given different names. The first fruit, which they name fornites, are the autumnal figs; they appear in August, and fall in September and October. The second figs, called cratitires, are the winter figs, and remain on the trees from September till May; then come the third kind, or spring figs, known in the country by the name of orni. None of these fruits ripen, but they have a sleek even skin, of a deep green colour, and contain in their dry and mealy inside several male and female flowers, placed upon distinct footstalks, the former above the latter. In the first figs, or fornites, are bred small worms, which change to a species of cynips, peculiar to these trees. In October and November, these insects of themselves make a puncture into the second fruit, after

which the autumnal figs fall; but the winter fruit, or cratitires, remain, as we have observed, till May, and enclose the eggs deposited by the gnats when they pricked them. In May the third sort of fruit, called orni, begin to be produced by the wild fig-trees. This is much bigger than the other two; and when it grows to a certain size, and its bud begins to open, it is pricked in that part by the cynips of the winter figs, which are strong enough to go from one fruit to another to deposit their eggs. It sometimes happens that the insects of the cratitires are slow to come forth in certain parts, while the orni in those very parts are ready to receive them. In this case the husbandman is obliged to look for the cratitires in another part, and fix them at the ends of the branches of those fig-trees whose orni are fit to be pricked by the insects. If they miss the opportunity, the orni fall, and the insects from the winter figs fly away. None but those who are well acquainted with the culture know the critical moment of doing this; and in order to know it, their eye is perpetually fixed on the bud of the fig; for that part not only indicates the time that the insects are to issue forth, but also when the fig is to be successfully pricked: if the bud is too close, the fly cannot deposit its eggs; if, on the contrary, it is too open, the fruit falls to the ground. None of the wild figs are good to eat; their chief use is to assist in ripening the domestic kind, and the manner in which this is effected is as follows: during the months of June and July, the peasants take the orni at the time their insects are ready to break out, and carry them to the garden fig-trees; if they miss the proper time, the orni fall, and the fruit of the domestic fig will in consequence prove barren, and fall also. The natives are so well acquainted with these precious moments, that, every morning, in making their inspection, they only transfer to their garden fig-trees such orni as are well conditioned, otherwise they lose their crop. In this case, however, they have one remedy, which is to strew over the garden fig-trees another plant, in whose fruit there is also a species of insect, which in some measure answers the purpose. The countrymen so well understand how to manage their orni, that the flies which proceed from them ripen their domestic figs in the space of forty days.

FIDDLE. See VIOLIN.

FIELD, in heraldry, is the whole surface of the shield, or the continent, so called because it containeth those atchievements anciently acquired in the field of battle. It is the ground on which the colours, bearings, metals, furs, charges, &c. are represented. Among the modern heralds, field is less frequently used in blazoning than shield or escutcheon. See SHIELD, &c.

FIELD *book*, in surveying, that wherein the angles, stations, distances, &c. are set down. See SURVEYING.

FIELD *colours*, in war, are small flags of about a foot and a half square, which are carried along with the quarter-master general, for marking out the ground for the squadrons and battalions.

FIELD *fare*, in ornithology, the English name of the variegated turdus, with a hoary head. See TURDUS.

FIELD *pieces*, small cannons, from three to twelve pounders, carried along with an army in the field. See CANNON.

FIELD *staff*, a weapon carried by the gunners, about the length of a halbert, with a spear at the end; having on each side, ears screwed on, like the cock of a match lock, where the gunners screw in lighted matches, when they are upon command; and then the field-staffs are said to be armed.

FIELD *works*, in fortification, are those thrown up by an army in besieging a fortress, or by the besieged to defend the place. Such are the fortifications of camps, highways, &c.

FIFE, in music, is a sort of wind instrument, being a small pipe.

FIFTEENTH, an ancient tribute or tax laid upon cities, boroughs, &c. through all England, and so termed because it amounted to a fifteenth part of what each city or town had been valued at; or it was a fifteenth of every man's personal estate according to a reasonable valuation. In doomsday-book, there are certain rates mentioned for levying this tribute yearly; but since, any such tax cannot be levied but by parliament.

FIFTH, in music, one of the harmonical intervals or concords. The fifth is the second in order of the concords, the ratio of the chord that affords it is 3 : 2. It is called a fifth, as containing five terms or sounds between its extremes, and four degrees, so that in the natural scale of music, it comes in the fifth place or order from the fundamental. The ancients called this fifth diapente. The imperfect and defective fifth called by the ancients semi-diapente is less than the fifth by a lesser semitone.

FIG, the fruit of the ficus, or fig-tree. See Ficus.

FIGURAL, or Figurate *numbers*, are such as do or may represent some geometrical figure in relation to which they are always considered, as triangular numbers, pentagonal numbers, pyramidal numbers, &c.

FIGURATE *numbers*, are distinguished into orders according to their place in the scale of their generation, being all produced one from another, *viz.* by adding continually the terms of any one, the successive sums are the terms of the next order, beginning from the first order, which is that of equal units 1, 1, 1, 1, &c.; then the 2d order consists of the successive sums of those of the first order, forming the arithmetical progression 1, 2, 3, 4, &c.; those of the 3d order the successive sums of those of the 2d, and are the triangular numbers 1, 3, 6, 10, 15, &c.; those of the 4th order are the successive sums of those of the 3d, and are the pyramidal numbers 1, 4, 10, 20, 35, &c.; and so on, as below.

Order.	Name.	Numbers.				
1.	Equals	1,	1,	1,	1,	1, &c.
2.	Arithmetical	1,	2,	3,	4,	5, &c.
3.	Triangulars	1,	3,	6,	10,	15, &c.
4.	Pyramidals	1,	4,	10,	20,	35, &c.
5.	2d Pyramidals	1,	5,	15,	35,	70, &c.
6.	3d Pyramidals	1,	6,	21,	56,	126, &c.
7.	4th Pyramidals	1,	7,	28,	84,	210, &c.

The above are all considered as different sorts of triangular numbers, being formed from an arithmetical progression, whose common difference is 1. But if that common difference is 2, the successive sums will be the series of square numbers; if it be 3, the series will be pentagonal numbers, or pentagons; if it be 4, the series will be hexagonal numbers, or hexagons, and so on. Thus:

Arithmetical.	1st. Sums or Polygons.	2d. Sums, or 2d. Polygons.
1, 2, 3, 4,	Tri. 1, 3, 6, 10,	1, 4, 10, 20,
1, 3, 5, 7,	Sqrs. 1, 4, 9, 16,	1, 5, 14, 30,
1, 4, 7, 10,	Pent. 1, 5, 12, 22,	1, 6, 18, 40,
1, 5, 9, 13,	Hex. 1, 6, 15, 28,	1, 7, 22, 50, &c.

And the reason of the names triangles, squares, pentagons, hexagons, &c. is, that those numbers may be placed in the form of these regular figures or polygons. The figurate numbers of any order, may be found without computing those of the preceding order, which is done by taking the successive products of as many of the terms of the arithmeticals 1, 2, 3, 4, 5, &c. in their natural order, as there are units in the number which denominates the order of figurates required, and dividing those products always by the first product: thus the triangular numbers are found by dividing the products 1×2; 2×3; 3×4, &c. each by the first product 1×2: the first pyramids by dividing the products $1 \times 2 \times 3$; $2 \times 3 \times 4$, &c. by the first $1 \times 2 \times 3$. And in general, the figurate numbers of any order n are found by substituting successively 1, 2, 3, 4, 5, &c. instead of z in this general expression $\frac{z \times \overline{z+1} \times \overline{z+2} \times \overline{z+3}, \&c.}{1 \times 2 \times 3 \times 4, \&c.}$; where the factors in the numerator and denominator are supposed to be multiplied together, and to be continued till the number in each be less by 1 than that which expresses the order of the figurates required. See Simpson's Algebra.

FIGURE, in physics, expresses the surface or terminating extremities of any body; and considered as a property of body affecting our senses, is defined a quality which may be perceived by two of the outward senses. Thus a table is known to be square by the sight, and by the touch.

Figures, in arithmetic, are certain characters whereby we denote any number which may be expressed by any combination of the nine digits, &c. See Digit.

Figure, in botany, a property of natural bodies, from which marks and distinctive characters are frequently drawn. Figure is more constant than number; more variable than proportion and situation. The figure of the flower in the same species is more constant than that of the fruit: hence Linnæus advises to arrange under the same genus such plants as agree invariably in the flowers, that is, in the calyx, petals, and stamina, although the fruit or seed-vessel should be very different. The seed-vessels of the different species of French honeysuckle, wild senna, acacia, Syrian mallow, and sophora, are exceedingly diversified in point of figure. Hence some former botanists, who paid more attention to the parts of the fruit, considered many of these spe-

cies as distinct genera, and denominated them accordingly. The figure of the seed-vessel is a very common specific difference in the Sexual Method.

FIGURE, in dancing, denotes the several steps which the dancer makes in order and cadence, considered as they mark certain figures on the floor.

FIGURE, in fortification, the plan of any fortified place, or the interior polygon, which, when the sides and angles are equal, is called a regular, and when unequal, an irregular figure.

FIGURE, in geometry, the superficies included between one or more lines, is denominated either rectilinear, curvilinear, or mixed, according as the extremities are bounded by right lines, curve lines, or both.

FIGURE, in grammar, a deviation from the natural rules of etymology, syntax, and prosody, either for brevity, elegance, or harmony.

FIGURE, in logic, denotes a certain order and disposition of the middle term in any syllogism.

FIGURE, in painting and designing, denotes the lines and colours which form the representation of any animal, but more particularly of a human personage. Thus a painting is said to be full of figures, when there are abundance of representations of men; and a landscape is said to be without figures, when there is nothing but trees, plants, mountains, &c.

FIGURE, in rhetoric, is a manner of speaking different from the ordinary and plain way, and more emphatical; expressing a passion, or containing a beauty. See RHETORIC.

FILACER, or *filizer*, an officer of the Court of Common Pleas, so called because he files those writs whereon he makes out process.

FILAGO, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate: female, florets among the scales of the calyx; down none; receptacle naked. There are seven species.

FILAMENT, in physiology and anatomy, denotes much the same as fibre. See FIBRE.

FILAMENT, in botany, the lower, slender, or thread-shaped part of the stamina, that serves as a foot-stalk for elevating the nthers, and connecting them with the vegetable. The term is equivalent to the stamen of Tournefort, and other botanists With Linnæus stamen is a general term, the two parts of which are, the filament or thread, and the anthera or summit. From the number of the filaments the first thirteen classes in the "Sexual Method" arise. With respect to figure, filaments are either slender, like a hair, as in plantain; flat, as in star of Bethlehem; wedge-shaped, as in meadow-rue; twisted like a screw, as in hirtella; awl-shaped, as in tulip; notched, as in many of the lip-flowers; or bent backwards, as in superb lily. The filaments in spider-wort and flower-of-a-day are beautifully covered with a fine hairy down. As to proportion, the filaments are either very long, as in plantain; very short, as in arrow-headed grass; of equal lengths, as in most flowers; or irregular and unequal, as in the lip and cross-shaped flowers, which, from this circumstance, constitute the classes Didynamia and Tetradynamia in Linnæus's Method. The situation of the filaments is generally opposite to the divisions of the calyx, and alternate with the petals.

FILAMENTS, vegetable, form a substance of great use in the arts and manufactures, furnishing thread, cloth, cordage, &c. For these purposes the filamentous parts of hemp and flax are employed among us. Different vegetables have been employed in different countries for the same uses. In some parts of Sweden a strong cloth is said to have been prepared from the stalks of hops. These have been tried here, but without success. Vegetable filaments, and the thread or cloth prepared from them, differ remarkably from wool, hair, silk, and other animal productions, particularly in their disposition to imbibe colouring matters; sundry liquors, which give a beautiful and durable dye to those of the animal, giving no stain at all to those of the vegetable kingdom. See DYEING.

FILARIA, in natural history, a genus of the Vermes Intestina class and order. Body round, filiform, equal, and quite smooth; mouth dilated, with a roundish concave lip. There are about 18 species, divided into four sections: *viz.* A. infesting the mammalia; B. infesting birds; C. infesting insects in their perfect state; D. infesting the larvæ of insects. F. medinensis is found both in the East and West Indies, and is frequent in the morning dew, from which it enters the naked feet of the slaves, and creates the most troublesome itching, frequently accompanied with inflammation and fever. There is great difficulty in extricating it

from its hold; the only method is, by cautiously drawing it out, by means of a piece of silk tied round its head; for if, by being too hasty, the animal should break, the part remaining under the skin grows with surprising vigour, and occasions an alarming, sometimes a fatal inflammation. It is frequently 12 feet long, and not larger than a horse-hair.

FILBERT, the fruit of the corylus, or hazel. See CORYLUS.

FILES, *manufactory of.* Many useful tools have been invented for performing mechanical operations, which consist of a number of wedges or teeth, which may be conceived to stand upon, or rise out of a flat or curved metallic surface. When these teeth are formed upon the edge of a plate, the instrument is called a saw; but when they are formed upon a broad surface, it constitutes what is known by the name of a file. The comb-makers and others use a tool of this description, called a quonet, having coarse single teeth, to the number of about seven or eight in an inch. Fine tools of the same kind, namely, with single teeth, are called floats. When the teeth are crossed, they are called files; and when instead of the notches standing in a right line, a number of single individual teeth are raised all over the surface, it is called a rasp. As the art of making files is nearly the same in its practice with regard to all the great variety of forms in which they are made, we shall confine our description to that of the flat file.

Very little need be said in explanation of the method of forging these articles. They are usually made of steel, or more rarely of iron, case-hardened. The forged files are brought to a flat surface on the grindstone, and are then ready for the file-cutter. This artist is provided with a great number of chissels, consisting each of a piece of steel of moderate thickness, having a straight edge, of greater length than the height of the chissel, the back of which terminates in a blunt angle or point in the middle of its length, upon which the blows are struck with a hammer of about five or six pounds weight, for middling sized files, having its head all on one side of the stem, so as to resemble the capital letter L, in order that it may by its own weight naturally dispose itself with the face downwards. The file is placed upon a plate of lead on a small low anvil, close to which the workman sits, and on the left side of the block of the anvil are fastened the two ends of a leather strap, which he brings over the file, and by putting his right foot into the loop, holds it steadily in its place. In this situation, taking the chissel between his left finger and thumb, he applies its edge across the file, where the cuts are to begin at the point, and gives it a blow; the direction of the cut being inclined towards the tang, or that end of the file, which is to go into the handle. Immediately after this commencing operation, he lifts the chissel, places its edge behind the other cut, and slides it forward till he feels it bear against the bur or protuberancy of the former cut, at which instant he gives the second blow; a third is repeated in like manner, and by a continuance of the same proceeding, the whole surface at length becomes covered with single strokes or notches, each of which presents an elevated sharp edge. The distance between stroke and stroke, or which is the same thing, the coarseness of the file depends entirely upon the violence of the blow, by which the bur is raised to a greater or a less height; but it is not difficult with so weighty a hammer, after a very little practice to give the strokes with great uniformity of impulse, and to repeat them with such frequency as to perform this apparently delicate work with great speed and precision. The coarsest files have about ten or twelve cuts in the inch of length, and the very finest have upwards of two hundred.

As soon as the whole surface of the file has been thus cut, the workman files the bur off with a smooth file, so as to leave very little more of the stroke than what has entered below the original surface; and then proceeds to give the second or cross-cut forming an angle of about sixty degrees, with the first range of strokes. The intention to be answered by filing off the first edges is to afford a more even surface for cutting the second, which is done exactly in the same manner as the first range, and likewise to give a suitable figure to the small teeth or lozenge-shaped prominences, which stand up upon the face of the file after the cutting is completed. If this filing off were to be omitted, the teeth would be pointed and irregular; whereas the useful and durable figure is that of a small rounded chissel or gouge.

It may be remarked, upon examining a file, that the first cut is always made more slantwise than the second. If this were not done, the small teeth would all lie behind one another, in rows in the direction of the length of the file, which would make cor-

responding grooves in the face of any piece of work, that might be to be filed, instead of leaving the workman at liberty to vary his strokes, as is necessary when a flat surface is to be produced.

When the file is cut and finished on both sides, and on one or both edges, as may be required, it is ready for hardening, which is a chemical operation of some skill and ingenuity. The heat is given in a furnace, where the work can be regularly disposed, and for fine work a muffle is used. The file is first exposed to a low degree of ignition, which burns off any greasy or other matter, that might adhere to its surface. It is then dipped, cold, in the grounds or thick sediment of beer, and while wet into a powder made of burned or parched horn, or leather, or other coally animal matter, and of common salt, and in this state speedily dried by exposure to heat. Any other mucilage which could be afforded at a moderate price, would probably answer the same purpose as the beer grounds. The file being then put into the ignited muffle, smokes and soon becomes red-hot, being not only defended from oxydation, by the covering of fused salt, and animal coal, which envelopes it on all sides, but being even rendered more steely upon its surface by the absorption of carbon. As soon as it has acquired the low red heat called cherry-red, it is taken out and plunged into pure cold water, which instantly cools it, and renders it very hard.

There are several variations adopted in the hardening process by different workmen, by means of which they differ in their success. Some file-makers, as well as gunsmiths and locksmiths, produce the intended effect so completely, that the whole surface of their work has a beautiful dull-grey aspect, every where alike; whereas, other operators produce coally spots, which are obliged to be cleaned off. The files, when quite dry and clean, are slightly oiled, and kept in oiled paper.

The simple operation of file-cutting seems to be of such easy performance, that it is not at all to be wondered at that machines for this purpose should have been very early invented. Mathurin Jousse, in "La Fidelle Ouverture de l'Art de Serrurier," published at La Fleche, in Anjou, in 1627, gives a drawing and description of one, in which the file is drawn along by shifts by wheel-work, and the blow is given by a hammer, which is tripped by the machinery. There are several in the "Machines Approuvées par l'Academie Royale de Paris;" and one in the "American Transactions;" and a patent was granted a few years ago, for improvements in the art, to the editor of this work.

The principal requisites in a machine for file-cutting are, that the file should be steadily supported, and the chizel adapted to the face without any unequal bearing. Files are however, for the most part, cut by hand; and the chief reasons are, 1. The cut by hand is, from its very nature, exactly of the depth the bur demands; whereas, in a machine, if the stroke be not nicely adapted to the shift, the file may be either shallow-cut, or its bur may be thrown too close by an over heavy stroke; and, 2. In machine-cut files, there must always be a piece left at the beginning, at each corner, which requires to be cut off before hardening. This may be remedied in the machinery, but it has not yet been done.

FILICES, *ferns*, one of the seven families or natural tribes into which the whole vegetable kingdom is divided by Linnæus, in his "Philosophia Botanica." They are defined to be plants which bear their flower and fruit on the back of the leaf or stalk, which in this class of imperfect plants are the same. In the Sexual System, the ferns constitute the first order, or secondary division of the twenty-fourth class, Cryptogamia; in Tournefort's Method they are the sixteenth class; and in Ray's the fourth, under the name of Capillares. Haller denominates them Epiphyllospermæ, that is, plants that bear their seed on the back of the leaf; others term them Acaules, because they have properly no stem. These plants in figure approach the more perfect vegetables, being furnished, like them, with roots and leaves. The roots creep, and extend themselves horizontally under the earth, throwing out a number of very slender fibres on all sides. The stem in these plants is not to be distinguished from the common foot-stalk, or rather middle rib of the leaves; so that in strict propriety the greater number of ferns may be said to be Acaules, that is, to want the stem altogether: in plants of the second section, however, the middle rib, or a stalk proceeding from the root, overtops the leaves, and forms a stem upon which the flowers are supported. The leaves proceed either singly or in greater numbers from the extremities of the branches of the main root. They are winged, or hand-shaped, in all the genera, except in adder's-tongue, pepper-grass, and some species of spleen-wort. The flowers of the

ferns, whatever be their nature, are in the greater number of genera fastened, and as it were glued to the back of the leaves; in some they are supported upon a stem or stalk, which rises above the leaves, and is either, as we said above, a prolongation of their middle rib, or issues out of the centre of the plant, unconnected with the leaves altogether. From these different modes of flowering arise the two sections, or divisions, of this natural order; *viz.* 1. those in which the parts of fructification grow upon the leaves; 2. those in which the flowers are borne upon foot-stalks that overtop the leaves.

FILLAGREE *work*, a kind of enrichment on gold or silver, wrought delicately, in manner of little threads or grains, or both intermixed. In Sumatra, manufactures of this kind are carried on to very great perfection. But what renders this a matter of great curiosity is, that the tools made use of are very coarse and clumsy. The gold is melted in a crucible of their own forming, and, instead of bellows, they blow with their mouths through a piece of bamboo. They draw and flatten the wire in a manner similar to that adopted by Europeans. It is then twisted, and thus a flower, or the shape of a flower, is formed. Patterns of the flowers or foliage are prepared on paper, of the size of the gold plate on which the fillagree is to be laid. According to this they begin to dispose on the plate the larger compartments of the foliage, for which they use plain flat wire, of a larger size, and fill them up with the leaves. A gelatinous substance is used to fix the work, and after the leaves have been placed in order, and stuck on, bit by bit, a solder is prepared of gold filings and borax, moistened with water, which they strew over the plate, and then putting it in the fire a short time, the whole becomes united. When the fillagree is finished, it is cleansed with a solution of salt and alum in water. The Chinese make most of their filagree of silver, which looks very elegant; but is deficient in the extraordinary delicacy of Malay work.

FILLET, in heraldry, a kind of orle or bordure, containing only a third or fourth part of the breadth of the common bordure. It is supposed to be withdrawn inwards, and is of a different colour from the field. It runs quite round, near the edge, as a lace over a cloak. It is also used for an ordinary, drawn like a bar, from the sinister point of the chief, across the shield, in manner of a scarf; though it sometimes is also seen in the situation of a bend, fesse, cross, &c.

FILM, a thin skin or pellicle. In plants it is used for that thin, woody skin, which separates the seeds in the pods, and keeps them apart.

FILTER, in chemistry, a strainer commonly made of bibulous or filtering paper in the form of a funnel, through which any fluid is passed, in order to separate the gross particles from it, and render it limpid. There are several filters made of flannel and linen cloth. The filter produces the same effect, with regard to liquids, that the sieve does in dry matters. Filters are of two sorts: the first are simple pieces of paper or cloth, through which the liquor is passed without farther trouble; the second are twisted up like a skein or wick, and first wetted, and then squeezed as dry as possible; one end is put into the liquor to be filtrated, the other end is to hang out below the surface of the liquor; by this means the purest part of the liquor distils drop by drop out of the vessel, leaving the dregs behind: a filter of this kind acts upon the principle of the syphon. Water is freed from various impurities by means of basins made of porous stone; this is often very necessary at sea, when the water becomes foul, and on land, where there are no fresh springs. The filter is of use to all those in and near the metropolis, who are supplied with water from the Thames, the New River, and the ponds from Hampstead. Many patents have been obtained for filtering machines, which may be seen in various parts of London.

We shall observe, that Mr. Peacock obtained, about twelve years since, one for a new species of filtration, by means of gravel of different sizes, suitable to the several strata. The various sizes of the particles of gravel, as placed in layers, should be nearly in the quadruple ratio of their surfaces; that is, upon the first layer, a second is to be placed, the diameters of whose particles are not to be less than one-half of the first, and so on in this proportion. This arrangement of filtering particles will gradually fine the water, by the grosser particles being quite intercepted in their partly ascending with the water. An advantage in these filters is, that they may be readily cleansed by drawing out the body of the fluid, by which it will descend in the filter, and carry with it all the foul and extraneous substances.

A patent was also granted to Mr. Joshua Collier of Southwark, for a most ingenious method of filtering and sweetening water, oil, and every other liquid. The following is the contrivance which combines the application of machinery with the antiseptic properties of charcoal. Fish oil is one of the liquids which he had particularly in view, to free it from every thing disagreeable, either in taste, smell, or colour, to accomplish which he poured a quantity of oil into a convenient vessel, heated to the temperature of 120° of Frahenheit's thermometer, adding caustic mineral alkali of the specific gravity of 1.25. He then agitated the mixture, afterwards allowing it to stand till the sediment subsided, and then drew it off into another vessel, with a sufficient quantity of burnt charcoal finely powdered, and a small quantity of diluted sulphuric acid, to decompose the saponaceous matter still suspended in the oil, when the oil became clear at the surface; he then agitated the contents of this vessel, and left the coally, saline, and aqueous particles to subside; afterwards passing it through proper strainers, when it became quite transparent and fit for use.

The principle of the improved filtering machines consists in combining hydrostatic pressure with the mode of filtering *per ascensum*, which procures the peculiar advantage of causing the fluid and its sediment to take opposite directions. The filtering surface remains the same, while the dimensions of the chamber in which the sediment is received may be varied. To adapt the machines to every purpose for which they are intended, chambers must be provided of various capacities, for the precipitated matter. The space required is very great with respect to the oil trade, and as all dimensions will be required occasionally, no particular limits can be fixed. For distilleries and breweries they may be smaller in proportion, and a very small chamber will be sufficient for domestic economy. If water is to be freed from noxious particles, it must be made to pass through an iron box in its way to the filtering chamber, and the box must contain charcoal finely powdered; the water is received into this box, and delivered by two apertures, which are opened and closed by cocks. Another part of the invention consists in filtering machines in the form of stills, in which charcoal may be repeatedly burnt after any fluid substances have passed through it, for the purpose of freeing them from noxious particles, or discharging their colouring matter.

To the filtering apparatus of Mr. Collier, instruments are attached for discovering the comparative qualities of oils, which depend, in some measure, on their specific gravities; spermaceti oil, when compared with fish oils, being as 875 to 920. To do this, a glass vessel of any shape most convenient is employed, with a glass bubble, and a thermometer. If the oil is pure, the bubble sinks, when the mercury rises to a particular standard. When spermaceti oil is impure, the bubble floats, though of the temperature required. To determine the tendency of oils, used for burning, to congeal in cold weather, a freezing mixture may be put into a phial of thin glass, into which let a thermometer be immersed, and a single drop of the oil permitted to fall on the outside of the vessel, where it will instantly congeal. As the cold produced by the mixture decreases, let the temperature be observed, by the thermometer, at which the oil becomes fluid, and runs down the side of the glass.

FIN, in natural history, a well known part of fishes, consisting of a membrane supported by rays, or little bony or cartilaginous ossicles.

The number, situation, and figure of fins, are different in different fishes. As to number, they are found from one to ten, or more; with respect to situation, they stand either on the back only, the belly only, or on both; and as to figure, they are either of a triangular, roundish, or oblong square form. Add to this, that in some they are very small; whereas, in others, they almost equal to the whole body in length.

FINAL *letters*, among Hebrew grammarians, five letters so called, because they have a different figure at the end of words from what they have in any other situation. These are caph, mem, nun, phe, tzade, all comprehended in the word *camnephatz;* which, at the end of words, are written thus, ךםןףץ; whereas, in any other situation, their form is thus, כמנפצ, on which account they are likewise called biform.

FINANCES, in political economy, denote the revenue of a king or state.

In former times, when the whole revenue drawn from the people, by a few taxes, was considered as the personal property of the sovereign, the purposes to which it was applied depended on his discretion, or that of his minister. As few princes were inclined,

in times of peace, to provide for the extraordinary charges of a state of warfare, these were defrayed by extraordinary contributions from the people, which ceased with the occasion. Few sovereigns possessed sufficient credit, either with their own subjects or foreigners, to contract debts, so that at the conclusion of a war, there was no occasion for a greater expenditure than before its commencement, and the revenue drawn from the people reverted to its former state. It is the system of defraying extraordinary expences by borrowing the money, for which an annual interest must be paid; and of suffering the debts thus incurred to accumulate, by which the sum to be annually paid is continually increasing, and the expences of every war are rendered far greater than those which preceded it, that has swelled the revenue and expenditure of most of the nations of Europe to an enormous magnitude, and caused their systems of finance to become complicated and oppressive.

In Great Britain, where the system of running in debt, or, as it is commonly termed, the funding system, has been carried to a greater height than in any other country, its natural attendants, enormous taxation and expenditure, have made equal progress; and it is probably owing chiefly to the publicity which is given to all matters of finance, so that every person, with little trouble, may know how all the money raised for the public service is expended, that the people have been induced to submit to taxes, which both from their nature and amount would have appeared incredible to their forefathers.

The English system of finance rests on the produce of the various taxes which have been imposed at different periods, the aggregate amount of which, after deducting the expences of collection, together with a few small articles which cannot properly be called taxes, forms the whole of the public income: this income is annually appropriated to the several branches of the national expenditure, and when, in consequence of any extraordinary expences, it is known that the income of the current year will be insufficient to meet all the demands upon it, it is usual to borrow the sum necessary to make up the deficiency, either from individuals or public bodies, and to allow a fixed rate of interest on the money thus obtained, till the principal shall be repaid, or till the period originally agreed upon shall have expired.

FINE, in law, is sometimes called a feoffment of record; or rather, it is an acknowledgement of a feoffment on record: it has at least the effect of a feoffment in conveying lands, though it is one of those conveyances at the common law, by which lands and freeholds will pass without livery or seisin. It is an amicable composition of a suit, either actual or fictitious, by leave of the King's justices, whereby the lands in question become, or are acknowledged to be, the right of one of the parties. It is now a very general mode of conveyance by reason of its extensive and binding effect. There are four sorts of fines, but that most usually employed is called *fine sur conusance du droit come ceo q'uil a de son done*, or a fine upon acknowledgment of the right of the cognizee, as that which he hath of the gift of the cognizor. The purposes for which fines are now levied, are to cut off estates tail, to bar the wife of her dower, and also to make purchasers more secure in their title; for by virtue of the statute 4 Henry VII. c. 24, all persons not within age, and not under disability, such as femmes coverts, persons insane, and beyond sea, are barred of their rights by a fine levied of lands, with proclamation, unless they claim within five years. The legal learning, with respect to the effect and operation and mode of levying fines, is so abstruse, that, in a general dictionary, it is better to consider them only, as in fact they are, a species of solemn conveyance for the barring the wife of dower when levied by her, which she is enabled to do notwithstanding coverture, or to cut off entails, &c. than to attempt an imperfect description of fines in particular.

FINERY, in the iron works, one of the forges at which the iron is hammered and fashioned into what they call a bloom or square bar. See IRON.

FINESSE, a French term, current in this country, and is used chiefly to denote that subtilty made use of for the purposes of deception.

FINGER *board*, in music, that thin, black covering of wood laid over the neck of a violin, violincello, &c. on which, in performance, the strings are pressed by the fingers of the left hand, while the right manages the bow.

FINGERING, in music, the art of disposing the fingers in a convenient, natural, and apt manner, in the performance of any instrument, but more especially the organ and piano-forte. One of the first things

that a skilful master teaches is good-fingering, and to attain this, a pupil should spare no pains so as to be able to give passages with articulation, accent, and expression.

FINGERS, the extreme part of the hand, divided into five members. See ANATOMY. The names of the fingers, reckoning from the thumb, are, 1. Pollex. 2. Index. 3. Medius. 4. Annularis. 5. Auricularis.

FINING, or *Refining*. See CLARIFICATION and REFINING.

FINITE, something bounded or limited, in contra-distinction to infinite.

FIRE. The word heat has been used with so much precision by Doctors Black, Irvine, Crawford, and others, that the word fire seems to have been rendered of little use, except to denote a mass of matter in a state of combustion, which is, indeed, its vulgar acceptation. The term has, however, been used by many eminent writers, to denote what these great philosophers call the matter of heat, now generally termed CALORIC, which see.

FIRE, *balls of*, in meteorology, a kind of luminous bodies, generally appearing at a great height above the earth, with a splendour surpassing that of the moon; and sometimes equalling her apparent size. They generally proceed in this hemisphere from north to south with vast velocity, frequently breaking into several smaller ones, sometimes vanishing with a report, sometimes not. These luminous appearances no doubt constitute one part of the ancient prodigies, blazing-stars or comets, which last they sometimes resemble in being attended with a train; but frequently they appear with a round and well defined disk. The first of these of which we have any accurate account, was observed by Dr. Halley and some other philosophers at different places, in the year 1719. From the slight observations they could take of its course among the stars, the perpendicular height of this body was computed at about seventy miles from the surface of the earth. The height of others has also been computed, and found to be various; though in general it is supposed to be beyond the limits assigned to our atmosphere, or where it loses its refractive power. The most remarkable of these on record appeared on the 18th of August 1783, about 9 o'clock in the evening. It was seen to the northward of Shetland, and took a southerly direction for an immense space, being observed as far as the southern provinces of France, and one account says, that it was seen at Rome also. During its course it appeared frequently to have changed its shape; sometimes appearing in the form of one ball, sometimes of two or more; sometimes with a train, sometimes without one. It passed over Edinburgh nearly in the zenith, and had then the appearance of a well-defined round body, extremely luminous, and of a greenish colour; the light which it diffused on the ground, giving likewise a greenish cast to objects. After passing the zenith it was attended by a train of considerable length, which continually augmenting, at last obliterated the head entirely; so that it looked like a wedge, flying with the obtuse end foremost. The motion was not apparently swift, by reason of its great height; though in reality it must have moved with great rapidity, on account of the vast space it travelled over in a short time. In other places its appearance was very different. At Greenwich we are told, that two bright balls parallel to each other led the way, the diameter of which appeared to be about two feet; and were followed by an expulsion of eight others, not elliptical, seeming gradually to mutilate, for the last was small. Between each two balls a luminous serrated body extended, and at the last a blaze issued which terminated in a point. Minute particles dilated from the whole. The balls were tinted first by a pure bright light, then followed a tender yellow, mixed with azure, red, green, &c.; which, with a coalition of bolder tints, and a reflection from the other balls, gave the most beautiful rotundity and variation of colours, that the human eye could be charmed with. The sudden illumination of the atmosphere, and the form and singular transition of this bright luminary, tended much to make it awful: nevertheless, the amazing vivid appearance of the different balls, and other rich connective parts not very easy to delineate, gave an effect equal to the rainbow in the full zenith of its glory.

FIRE, *Extinguishing of*. The world has long been of an opinion, that a more ready way, than that in general use, might be found for extinguishing fires in buildings; and it has been generally attempted upon the doctrine of explosion. Zachary Greyl was the first person who put this plan into execution with any tolerable degree of success. He contrived certain engines, easily manageable, which he proved, before some persons of the first rank, to be of sufficient efficacy, and offered to discover

the secret by which they were contrived for a large premium, given either from the crown, or raised by a subscription of private persons. But the scheme meeting with no better success than things of this nature usually do, he died without making the discovery. Two years after this, the person, who had his papers, found the method, and it was shewn before the King of Poland and a great concourse of nobility at Dresden, and the secret purchased at a very considerable price. Afterwards, the same person carried the invention to Paris, and many other places, and practised it every where with success. The secret was this: A wooden vessel was provided, holding a very considerable quantity of water: in the centre of this was fixed a case made of iron plates, and filled with gun-powder; from this vessel, to the head of the larger vessel containing the water, there was conveyed a tube or pipe, which might convey the fire very readily through the water to the gun-powder contained in the inner vessel. This tube was filled with a preparation easily taking fire, and quickly burning away; and the manner of using the thing was, to convey it into the room or building where the fire was, with the powder in the tube lighted. The consequence of this was, that the powder in the inner case soon took fire, and with a great explosion burst the vessel to pieces, and dispersed the water every way; thus was the fire put out in an instant, though the room was flaming before in all parts at once. The advantage of this invention was, that, at a small expense, and with the help of a few people, a fire in its beginning might be extinguished; but the thing was not so general as it was at first expected that it would prove, for though of certain efficacy in a chamber or close building, where a fire had but newly begun, yet when the mischief has increased so far that the house was fallen in, or the top open, the machine had no effect.

Fire *in chimneys, method of extinguishing*. It is well known, that the inner parts of chimneys easily take fire; the soot that kindles therein emits a greater flame, according as the tunnel is more elevated, because the current of air feeds the fire. If this current could therefore be suppressed, the fire would soon be extinguished. In order to this, some discharge a pistol into the chimney, which produces no effect. Water thrown into the chimney at the top is equally useless, because it comes down through the middle of the tunnel, and not along the sides. It would be more advisable to stop, with a wet blanket, the upper orifice of the tunnel; but the surest and readiest method is, to apply the blanket either to the throat of the chimney; or over the whole front of the fire-place. If there happens to be a chimney-board or a register, nothing can be so effectual as to apply them immediately; and having by that means stopped the draught of air from below, the burning soot will be put out as readily and as completely as a candle is put out by an extinguisher, which acts exactly upon the same principle. Mr. Smart's machine for sweeping chimneys is admirably adapted to extinguish those that are on fire. See Chimney-*sweeping*.

Fire, *securing buildings against*. Dr. Hales proposes to check the progress of fires by covering the floors of the adjoining rooms with earth. The proposal is founded on an experiment which he made with a fir board half an inch thick, part of which he covered with an inch depth of damp garden-mould, and then lighted a fire on the surface of the mould; though the fire was kept up by blowing, it was two hours before the board was burnt through, and the earth prevented it from flaming. The thicker the earth is laid on the floors, the better: however, Dr. Hales apprehends that the depth of an inch will generally be sufficient: and he recommends to lay a deeper covering on the stairs, because the fire commonly ascends by them with the greatest velocity. Mr. David Hartley made several trials in the years 1775 and 1776, in order to evince the efficacy of a method which he had invented for restraining the spread of fire in buildings. For this purpose, thin iron plates were well nailed to the tops of the joists, &c. the edges of the sides and ends being lapped over, folded together, and hammered close. Partitions, stairs, and floors, may be defended in the same manner; and plates applied to one side have been found sufficient. The plates are so thin as not to prevent the floor from being nailed on the joists, in the same manner as if this preventive was not used; they are kept from rust by being painted or varnished with oil and turpentine. The expense of this addition, when extending through a whole building, is reckoned at about five per cent. Mr. Hartley had a patent for this invention, and parliament voted a sum of money towards defraying

the expense of his numerous experiments. The same preservative may also be applied to ships, furniture, &c. Mr. Hartley's patent has long since expired. Earl Stanhope also discovered and published a very simple and effectual method of securing every kind of building against fire. This method he has divided into three parts, *viz.* under-flooring, extra-lathing, and inter-securing. The method of under-flooring is either single or double. In single under-flooring, a common strong lath of oak or fir, about one fourth of an inch thick, should be nailed against each side of every joist, and of every main timber, supporting the floor which is to be secured. Other similar laths are then to be nailed along the whole length of the joists, with their ends butting against each other. The top of each of these laths or fillets ought to be at 1½ inch below the top of the joists or timbers against which they are nailed; and they will thus form a sort of small ledge on each side of all the joists. These fillets are to be well bedded in a rough plaster hereafter mentioned, when they are nailed on, so that there may be no interval between them and the joists; and the same plaster ought to be spread with a trowel upon the tops of all the fillets, and along the sides of that part of the joists which is between the top of the fillets and the upper edge of the joists. In order to fill up the intervals between the joists that support the floor, short pieces of common laths, whose length is equal to the width of these intervals, should be laid in the contrary direction to the joists, and close together in a row, so as to touch one another; their ends must rest upon the fillets, and they ought to be well bedded in the rough plaster, but are not to be fastened with nails. They must then be covered with one thick coat of the rough plaster, which is to be spread over them to the level of the tops of the joists; and in a day or two this plaster should be trowelled over close to the sides of the joists, without covering the tops of the joists with it. In the method of double-flooring, the fillets and short pieces of laths are applied in the manner already described; but the coat of rough plaster ought to be little more than half as thick as that in the former method. Whilst this rough plaster is laid on, some more of the short pieces of laths above-mentioned must be laid in the intervals, between the joists upon the first coat, and be dipped deep in it. They should be laid as close as possible to each other, and in the same direction with the first layer of short laths. Over this second layer of short laths there must be spread another coat of rough plaster, which should be trowelled level with the tops of the joists without rising above them. The rough plaster may be made of coarse lime and hair; or, instead of hair, hay chopped to about three inches in length may be substituted with advantage. One measure of common rough sand, two measures of slaked lime, and three measures of chopped hay, will form in general a very good proportion, when sufficiently beaten up together in the manner of common mortar. The hay should be put in after the two other ingredients are well beaten up together with water. This plaster should be made stiff; and when the flooring-boards are required to be laid down very soon, a fourth or fifth part of quicklime in powder, formed by dropping a small quantity of water on the limestone a little while before it is used, and well mixed with this rough plaster, will cause it to dry very fast. If any cracks appear in the rough plaster-work near the joist when it is thoroughly dry, they ought to be closed by washing them over with a brush wet with mortar-wash; this wash may be prepared by putting two measures of quicklime and one of common sand in a pail, and stirring the mixture with water, till the water becomes of the consistence of a thin jelly. Before the flooring-boards are laid, a small quantity of very dry common sand should be strewed over the plaster-work, and struck smooth with a hollow rule, moved in the direction of the joists, so that it may lie rounding between each pair of joists. The plaster-work and sand should be perfectly dry before the boards are laid, for fear of the dry-rot. The method of under-flooring may be successfully applied to a wooden staircase; but no sand is to be laid upon the rough plaster-work. The method of extra-lathing may be applied to ceiling joists, to sloping roofs, and to wooden partitions. The third method, which is that of inter-securing, is very similar to that of under-flooring; but no sand is afterwards to be laid upon it. Inter-securing is applicable to the same parts of a building as the method of extra-lathing, but it is seldom necessary. The author of this invention made several experiments, in order to demonstrate the efficacy of these methods. In most houses it is only necessary to secure the floors;

and the extra expense of under-flooring, including all materials, was at that time only about nine-pence per square yard, and with the use of quicklime a little more. The extra expense of extra-lathing is no more than six-pence per square yard for the timber side walls and partitions; but for the ceiling about nine-pence per square yard. But in most houses no extra-lathing is necessary.

Fire, in the art of war, a word of command to the soldiers, to discharge their musquets; to the cavalry, to discharge their carabines or pistols; to the grenadiers, to fire their grenadoes; and to the gunners, to fire the guns.

Fire, *running*, is when a rank of men, drawn up, fire one after another: or, when the lines of an army are drawn out to fire on account of a victory, each squadron or battalion takes it from another, from the right of the first line to the left, and from the left to the right of the second line.

Fire *arms* are all sorts of arms charged with powder and ball, as cannon, musquets, carabines, pistols, blunderbusses, &c. See Cannon, Gun, &c.

Fire *ball*, in the art of war, a composition of meal-powder, sulphur, salt-petre, pitch, &c. about the bigness of a hand-grenade, coated over with flax, and primed with a slow composition of a fusee. This is to be thrown into the enemy's works in the night-time to discover where they are: or to fire houses, galleries, or blinds of the besiegers; but they are then armed with spikes, or hooks of iron, that they may not roll off, but stick or hang where they are designed to have any effect.

Fire *pots*, in the military art, small earthern pots, into which is put a charged grenade, and over that powder enough till the grenade is covered; then the pot is covered with a piece of parchment, and two pieces of match across lighted: this pot being thrown by a handle of match, where it is designed, it breaks and fires the powder, and burns all that is near it, and likewise fires the powder in the grenade, which ought to have no fuse, to the end its operations may be the quicker.

Fire *ship*, in the navy, a vessel charged with artificial fire-works, which, having the wind of an enemy's ship, grapples her, and sets her on fire.

Fire *engine*. See Engine.

FIRKIN, an English measure of capacity, for things liquid, being the fourth part of the barrel: it contains nine gallons of beer.

FIRLOT, a dry measure used in Scotland. The oat-firlot contains 21¼ pints of that country; the wheat-firlot contains about 2,211 cubical inches; and the barley-firlot, 31 standard pints. Hence it appears that the Scotch wheat-firlot exceeds the English bushel by 33 cubical inches.

FIRMAMENT, in the Ptolemaic astronomy, the eighth heaven or sphere, with respect to the seven spheres of the planets which it surrounds. It is supposed to have two motions, a diurnal motion, given to it by the primum mobile, from east to west about the poles of the ecliptic; and another opposite motion from west to east, which last it finishes, according to Tycho, in 25,412 years; according to Ptolemy, in 36,000; and, according to Copernicus, in 25,800; in which time the fixed stars return to the same points in which they were at the beginning. This period is commonly called the Platonic year, or the great year.

FIRST *fruits* and *tenths*, in law. First fruits are the profits of every spiritual living for one year; and tenths are the tenth of the yearly value of such living, given anciently to the Pope throughout all Christendom; but by stat. 26 Hen. VIII. c. 3. transferred to the King of England. By stat. 27 Hen. VIII. c. 3. no tenths are to be paid for the first year, as then the first fruits are due; and by several statutes in the reign of Queen Ann, benefices under 50*l.* per ann. shall be discharged of the payment of first fruits and tenths. She also restored the profits of this revenue to the church, by establishing a perpetual fund therefrom, vested in trustees for the augmentation of poor livings under 50*l.* a year. This is called Queen Anne's bounty, and is further regulated by subsequent statutes; but as the number of livings under 50*l.* was at the commencement of it 5,597, averaged at 23*l.* per ann. its operation will be very slow.

FISC, in the civil law, the treasury of a prince. It differs from the ærarium, which was the treasury of the public or people: thus, when the money arising from the sale of condemned persons' goods was appropriated for the use of the public, their goods were said *publicari*; but when it was destined for the support of the prince they were called *confiscari*.

FISCAL, in the civil law, something relating to the pecuniary interest of the prince or people. The officers appointed for the management of the fisc were called *procuratores fisci*, and *advocati fisci*; and among the cases enumerated in the consti-

tutions of the empire, where it was their business to plead, one is against those who have been condemned to pay a fine to the fisc on account of their litigiousness, or frivolous appeals.

FISH, in natural history, constitutes a class of animals which have no feet, but always fins; add to this, that their body is either altogether naked, or only covered with scales; and that they are aquatic animals, which live mostly, if not always, in water. See PISCES.

FISH, in law, the property in fish in a river is in the lord of the manor, where he has the soil on both sides; but where the river ebbs and flows, and is an arm of the sea, it is common to all, and he who claims a privilege must prove it. To secure the property of fish in ponds, or drains, there are several statutes, creating offences and enacting punishments with respect to them, which are too numerous to be here mentioned.

FISHES, in heraldry, are the emblems of silence and watchfulness, and are borne either upright, imbowed, extended, endorsed respecting each other, surmounting one another, fretted, &c.

In blazoning fishes, those borne feeding should be termed devouring; all fishes borne upright and having fins should be blazoned hauriant; and those borne transverse the escutcheon must be termed naiant.

FISHERY, a place where great numbers of fish are caught.

The principal fisheries for salmon, herring, mackarel, pilchards, &c. are along the coasts of England, Scotland, and Ireland; for cod on the banks of Newfoundland; for whales, about Greenland; and for pearls, in the East and West Indies.

FISHERY denotes also the commerce of fish, more particularly the catching them for sale.

Were we to enter into a very minute and particular consideration of fisheries, as at present established in this kingdom, this article would swell beyond its proper bounds; because to do justice to a subject of that concernment to the British nation, requires a very ample and distinct discussion. We shall, however, observe, that since the coasts of Great Britain and Ireland abound with the most valuable fish; and since fisheries, if successful, become permanent nurseries for breeding expert seamen; it is a duty we owe to our country, for its natural security, to extend this trade to the utmost. No nation can have a navy, where there is not a fund of business to breed and employ seamen, without any expense to the public, and no trade is so well calculated for training up these useful members of this society, as fisheries.

The situation of the British coasts is the most advantageous for catching fish in the world; the Scottish islands, particularly those to the north and west, lie most commodious for carrying on the fishing trade to perfection; for no country in Europe can pretend to come up to Scotland in the abundance of the finest fish, with which its various creeks, bays, rivers, lakes, and coasts are replenished. King Charles I. was so sensible of the great advantage to be derived from fisheries, that he began the experiment, together with a company of merchants; but the civil war soon occasioned that project to be set aside. King Charles II. made a like attempt, but his pressing wants made him withdraw what money he had employed that way, whereupon the merchants that joined with him, did so too. Since the union, several attempts have been made to retrieve the fisheries, and a corporation settled to that effect, entitled the Royal British Fishery.

In the year 1750, the parliament of Great Britain taking the state of the fisheries into consideration, an act was passed for the encouragement of the white herring fishery, granting a charter, whereby a corporation is created, to continue twenty-one years, by the name of the Society of the Free British Fishery, to be under the direction of a governor, president, vice-president, council, &c. who are to continue in office the space of three years, with power to make by-laws, &c. and to raise a capital of 500,000*l.* by way of subscription. And any number of persons, who, in any part of Great Britain, shall subscribe 10,000*l.* into the stock of this society, under the name of the Fishing Chamber, and carry on the said fishery on their own account of profit and loss, shall be entitled to the same bounty allowed to the society. The bounty is 30*s.* the tun, to be paid yearly, for fourteen years, besides three per cent. for the money advanced by each chamber. The act contains other proper regulations relative to the nets, marks on the herring-barrels, number of hands, and the quantity of salt that is entitled to the bounty, &c. It is then by the encouragement given by this act, that we now see a laudable emulation

prevailing all over the two kingdoms, and fishing busses fitted out from almost every port, in order to repair to the Shetland islands, where the herring fishery is carried on with an ardour becoming so important a branch of trade. Scotland, which suffered incredibly from the neglect of this valuable and natural produce of the seas, has not been backward to join in a scheme that tends so evidently to its own advantage; for the cities of Edinburgh and Glasgow, the towns of Montrose, Dundee, Perth, Inverness, and some other boroughs, have raised the proper sum, and chambers have been erected in each of them; the gentlemen of estates adjoining to the respective places above-mentioned, liberally contributing with merchants towards the prosecution of an undertaking so visibly tending to the good of their country in general.

FISHERY, *anchovy*. Anchovies are fished on the coast of Provence, in the months of May, June, and July, at which season shoals of this fish regularly come into the Mediterranean through the Streights of Gibraltar. They are likewise found in plenty in the river of Genoa, on the coast of Sicily, and on that of the island of Gorgone opposite to Leghorn; these last are reckoned the best. It is remarkable that anchovies are seldom fished but in the night time. If a fire be kindled on the poops of the vessels used for this fishing, the anchovies will come in greater numbers into the nets; but then it is asserted, that the anchovies taken thus by fire, are neither so good nor so firm, and will not keep so well, as those which are taken without fire. When the fishery is over, they pull off the heads of all the anchovies, gut them, and afterwards range them in barrels of different weights, the largest of which do not weigh above twenty-five or twenty-six pounds, and they put a good deal of salt in them. Some also pickle them in small earthen pots made on purpose, of two or three pounds weight, more or less, which they cover with plaster, to keep them the better.

FISHERY, *cod*. There are two kinds of cod fish, the one green or white cod, and the other dried or cured cod, though it is all the same fish differently prepared; the former being sometimes salted and barrelled, then taken out for use; and the latter having lain some considerable time in salt, dried in the sun or smoke. We shall therefore speak of each of these apart, and first of

FISHERY, *green cod*. The chief fisheries for green cod are in the bay of Canada, on the great bank of Newfoundland, and on the isle of St. Peter, and the isle of Sable, to which places vessels resort from divers parts both of Europe and America. They are from 100 to 150 tons burthen, and will catch between 30 and 40 thousand cod each. The most essential part of the fishery, is to have a master who knows how to cut up the cod, one who is skilled to take the head off properly, and above all, a good salter, on which the preserving them, and consequently the success of the voyage depends. The best season is from the beginning of February to the end of April; the fish, which in the winter retire to the deepest water, coming then on the banks, and fattening extremely. What is caught from March to June keeps well, but those taken in July, August, and September, when it is warm on the banks, are apt to spoil soon. Every fisher takes but one at a time; the most expert will take from 350 to 400 in a day, but that is the most, the weight of the fish, and the great coldness on the bank, fatiguing very much. As soon as the cod are taken, the head is taken off; they are opened, gutted, and salted, and the salter stows them in the bottom of the hold, head to tail, in beds a fathom or two square; laying layers of salt and fish alternately, but never mixing fish caught on different days. When they have lain thus three or four days to drain off the water, they are replaced in another part of the ship, and salted again; where they remain till the vessel is loaded. Sometimes they are cut in thick pieces, and put up in barrels for the conveniency of carriage.

FISHERY, *dry cod*. The principal fishery for dry cod, is from Cape Rose to the Bay des Exports, along the coast of Placentia, in which compass there are divers commodious ports for the fish to be dried in. These, though of the same kind with the fresh cod, are much smaller, and therefore fitter to keep, as the salt penetrates more easily into them. The fishery of both is much alike, only this latter is more expensive, as it takes up more time, and employs more hands, and yet scarce half so much salt is spent in this as in the other. The bait is herrings, of which great quantities are taken on the coast of Placentia. When several vessels meet, and intend to fish in the same port, he whose shallop first touches ground, becomes entitled to the quality and privileges of admiral: he has the choice of his

station, and the refusal of all the wood on the coast at his arrival. As fast as the masters arrive, they unrig all their vessels, leaving nothing but the shrouds to sustain the masts, and in the mean time the mates provide a tent on shore, covered with branches of trees, and sails over them, with a scaffold of great trunks of pines, twelve, fifteen, sixteen, and often twenty feet high, commonly from forty to sixty feet long, and about one third as much in breadth. While the scaffold is preparing, the crew are fishing, and as fast as they catch they bring their fish ashore; open and salt them upon moveable benches; but the main salting is performed on the scaffold. When the fish have taken salt, they wash and hang them to drain on rails; when drained, they are laid on kinds of stages, which are small pieces of wood laid across, and covered with branches of trees, having the leaves stripped off for the passage of the air. On these stages they are disposed, a fish thick, head against tail, with the back uppermost, and are turned carefully four times every twenty-four hours. When they begin to dry, they are laid in heaps ten or twelve thick, in order to retain their warmth; and every day the heaps are enlarged, till they become double their first bulk; then two heaps are joined together, which they turn every day as before; lastly, they are salted again, beginning with those first salted, and being laid in huge piles, they remain in that situation till they are carried on board the ships, where they are laid on the branches of trees disposed for that purpose, upon the ballast, and round the ship, with mats to prevent their contracting any moisture.

There are four kinds of commodities drawn from cod, *viz.* the zounds, the tongues, the roes, and the oil extracted from the liver. The first is salted at the fishery, together with the fish, and put up in barrels from 6 to 700 pounds. The tongues are done in like manner, and brought in barrels from 4 to 500 pounds. The roes are also salted in barrels, and serve to cast into the sea to draw fish together, and particularly pilchards. The oil comes in barrels, from 400 to 520 pounds, and is used in dressing leather. The Scots catch a small kind of cod on the coast of Buchan, and all along the Murray Firth on both sides; as also in the Firth of Forth, Clyde, &c. which is much esteemed. They salt and dry them in the sun upon rocks, and sometimes in the chimney. They also cure skait, and other smaller fish in the same manner, but most of these are for home consumption.

FISHERY, *coral.* See CORAL *fishery.*

FISHERY, *herring.* Herrings are chiefly found in the North Sea. They are a fish of passage, and commonly go in shoals, being very fond of following fire or light, and in their passage they resemble a kind of lightning. About the beginning of June, an incredible shoal of herrings, probably much larger than the land of Great Britain and Ireland, come from the north on the surface of the sea: their approach is known by the hovering of sea fowl in expectation of prey, and by the smoothness of the water; but where they breed, or what particular place they come from, cannot be easily discovered. As this great shoal passes between the shores of Greenland and the North Cape, it is probably confined, and as it reaches the extremities of Great Britain, is necessarily divided into two parts. For we find one part of the herrings steering west, or south-west, and leaving the islands of Shetland and Orkney to the left, pass on towards Ireland, where, being interrupted a second time, some keeping the shore of Britain, pass away south, down St. George's channel; while the other part, edging off to the south-west, coast the western ocean, till they reach the south shore of Ireland, and then steering south-east, join the rest in St. George's channel. The other part of the first division made in the north, parting a little to the east and south-east, pass by Shetland, and then make the point of Buchan-ness, and the coast of Aberdeen, filling as they go all the bays, firths, creeks, &c. with their innumerable multitudes. Hence they proceed forward, pass by Dunbar, and rounding the high shores of St. Abbe's Head, and Berwick, are seen again off Scarborough; and even then not diminished in bulk, till they come to Yarmouth-Roads, and from thence to the mouth of the Thames, after which, passing down the British channel, they seem to be lost in the Western Ocean.

The vast advantage of this fishery to our nation is very obvious, when we consider that though herrings are found upon the shores of North America, they are never seen there in such quantities as with us, and that they are not to be met with in considerable numbers in any of the southern kingdoms of Europe, as Spain, Portugal, or the southern parts of France; on the side of the ocean, or in the Mediterranean, or on the coast of Africa. There are two seasons

for fishing herring, the first from June to the end of August, and the second in autumn, when the fogs become very favourable for this kind of fishing. The Dutch begin their herring-fishing on the 24th of June, and employ no less than 2000 vessels therein, called busses, being between 45 and 60 tons burden, and carrying three or four small cannon. They never stir out of port without a convoy, unless there be enough together to make about 18 or 20 cannon among them, in which case they are allowed to go in company. Before they go out, they make a verbal agreement, which has the same force as if it were in writing. The regulations of the admiralty of Holland are partly followed by the French, and other nations, and partly improved and augmented with new ones, as, that no fisher shall cast his net within a hundred fathoms of another boat: that while the nets are cast, a light shall be kept on the hind part of the vessel: that when a boat is by any accident obliged to leave off fishing, the light shall be cast into the sea: that when the greater part of a fleet leaves off fishing, and casts anchor, the rest shall do the same, &c. By the late act of parliament in Great Britain, the regulations are, that every vessel entitled to the bounty, must carry twelve Winchester bushels of salt in new barrels, for every last of fish such vessel is capable of holding; and as many more new barrels as such vessels can carry; and two fleets of tanned nets, that is, a vessel of seventy tons shall carry one fleet of 50 nets, each net to be 30 yards full upon its rope, and seven fathoms deep; and so in proportion for greater or smaller vessels; and be provided with one other fleet of fifty like nets, on board a tender, or left on shore in a proper place, for the use of the said vessel, &c.

There is nothing particular in the manner of fishing. The nets wherein the fish are drawn should regularly have their meshes an inch square to let all the lesser fry go through.

Curing and preparing herring. The commerce of herring, both white or pickled, and red, is very considerable. The white Dutch herrings are the most esteemed, being distinguished into four sorts, according to their sizes; and the best are those that are fat, fleshy, firm, and white, salted the same day they are taken with good salt, and well barrelled. The British herrings are little inferior, if not equal to the Dutch; for in spite of all their endeavours to conceal the secret, their method of curing, lasting, or casking the herrings, has been discovered, and is as follows. After they have hauled in their nets, which they drag in the sterns of their vessels backwards and forwards in traversing the coast, they throw them upon the ship's deck, which is cleared of every thing for that purpose; the crew is separated into sundry divisions, and each division has a peculiar task: one part opens and guts the herrings, leaving the melts and roes: another cures and salts them, by lining or rubbing their inside with salt: the next packs them, and between each row and division they sprinkle handfuls of salt: lastly, the cooper puts the finishing hand to all by heading the casks very tight, and stowing them in the hold. It is customary with us to wash the herring in fresh water, and steep them 12 or 15 hours in a strong brine before we proceed to barrel them.

Red herrings must lie 24 hours in the brine, in as much as they are to take all their salt there, and when they are taken out, they are spitted, that is, strung by the head on little wooden spits, and then hung in a chimney made for that purpose. After which a fire of brushwood, which yields a deal of smoke, but no flame, being made under them, they remain there till sufficiently smoked and dried, and are afterwards barrelled up for keeping.

FISHERY, *mackrel*. The mackrel are found in large shoals in the ocean, but especially on the French and English coasts. They enter the English channel in April, and proceeding as the summer advances, about June they are on the coasts of Cornwall, Sussex, Normandy, Picardy, &c. where the fishery is most considerable. They are taken either with a line or nets: the latter is preferable, and is usually performed in the night time. They are pickled two ways, first by opening and gutting them, and cramming their bellies as hard as possible with salt, by means of a stick, and then laying them in rows at the bottom of the vessel, strewing salt between each layer. The second way is putting them directly into tubs full of brine, made of salt and fresh water, and leaving them to steep till they have taken salt enough to keep. After this, they are barrelled up and pressed close down.

FISHERY, *pearl*. See PEARL *fishery*.

FISHERY, *pilchard*. The chief pilchard fisheries are along the coasts of Dalmatia, on the coast of Bretagne, and along the coasts of Cornwall and Devonshire. That of Dalmatia is very plentiful: that on the

coasts of Bretagne employs annually about 300 ships. The pilchards caught on our coasts, though bigger, are not so much valued as those on the coasts of France, owing principally to their not being so thoroughly cured. They naturally follow the light, which contributes much to the facility of the fishery: the season is from June to September. On the coasts of France they make use of the roes of the cod-fish, as a bait, which thrown into the sea, makes them rise from the bottom, and run into the nets: on our coasts there are persons posted ashore, who spying by the colour of the water where the shoals are, make signs to the boats to go among them to cast their nets. When taken, they are brought on shore to a warehouse, where they are laid up in broad piles, supported with backs and sides, and as they are piled they salt them with bay salt, in which lying to soak 20 or 30 days, they run out a deal of blood, with dirty pickle and bittern: then they wash them clean in sea-water; and when dry, barrel and press them hard down to squeeze out the oil, which issues out at a hole in the bottom of the cask. The Cornish men observe of the pilchard, that it is the least fish in size, most in number, and greatest for gain, of any they take out of the sea.

Fishery, *salmon*. The chief salmon fisheries in Europe are in England, Scotland, and Ireland, in the rivers and sea-coasts adjoining to the river mouths. Those most distinguished for salmon in Scotland, are the river Tweed, the Clyde, the Tay, the Dee, the Don, the Spey, the Ness, the Bewley, &c. in most of which it is very common about the height of summer, especially if the weather happen to be very hot, to catch four or five score of salmon at a draught. The chief rivers in England for salmon are the Tyne, the Trent, the Severn, and the Thames. The fishing usually begins about January, and in Scotland, they are obliged to give over about the 15th of August, because, as it is then supposed the fish come up to spawn, it would be quite depopulating the rivers to continue fishing any longer. It is performed with nets, and sometimes with a kind of locks or wears made on purpose, which in certain places have iron or wooden grates so disposed, in an angle, that being impelled by any force in a contrary direction to the course of the river, they may give way and open a little at the point of contact, and immediately shut again, closing the angle. The salmon, therefore, coming up into the rivers, are admitted into these grates, which open, and suffer them to pass through, but shut again, and prevent their return. Salmon are also caught with a spear, which they dart into him when they see him swimming near the surface of the water. It is customary likewise to catch them with a candle and lanthorn, or wisp of straw set on fire; for the fish naturally following the light, are struck with the spear, or taken in a net spread for that purpose, and lifted with a sudden jerk from the bottom. We make no mention of the method of catching salmon with a line or hook, because it is much the same with trout fishing.

Curing salmon. When the salmon are taken, they open them along the back, take out the guts and gills, and cut out the greatest part of the bones, endeavouring to make the inside as smooth as possible, then salt the fish in large tubs for the purpose, where they lie a considerable time soaking in brine, and about October they are packed close up in barrels, and sent to London, or exported up the Mediterranean. They have also in Scotland a great deal of salmon salted in the common way, which after soaking in brine a competent time, is well pressed, and then dried in smoke: this is called kipper, and is chiefly made for home consumption, and if properly cured and prepared, is reckoned very delicious.

Fishery, *sturgeon*. The greatest sturgeon fishery is in the mouth of the Volga, on the Caspian Sea, where the Muscovites employ a great number of hands, and catch them in a kind of inclosure formed by huge stakes, representing the letter Z, repeated several times. These fisheries are open on the side next the sea, and close on the other, by which means the fish ascending in the season up the river are embarrassed in these narrow angular retreats, and thus are easily killed with a harping-iron. Sturgeons, when fresh, eat deliciously; and in order to make them keep they are salted or pickled in large pieces, and put up in cags from thirty to fifty pounds. But the great object of this fishery is the roe, of which the Muscovites are extremely fond, and of which is made the cavear or kavia, so much esteemed by the Italians. See Cavear.

Fishery, *whale*. Whales are chiefly caught in the North Sea: the largest sort are found about Greenland, or Spitzbergen. At the first discovery of this country, whales not being used to be disturbed, frequently

came into the very bays, and were accordingly killed almost close to the shore, so that the blubber being cut off was immediately boiled into oil on the spot. The ships, in those times, took in nothing but the pure oil and the fins, and all the business was executed in the country, by which means, a ship could bring home the product of many more whales than she can according to the present method of conducting this trade. The fishery also was then so plentiful, that they were obliged sometimes to send other ships to fetch off the oil they had made, the quantity being more than the fishing ships could bring away. But time and change of circumstances have shifted the situation of this trade. The ships coming in such numbers from Holland, Denmark, Hamburgh, and other northern countries, all intruders upon the English, who were the first discoverers of Greenland, disturbed the whales, and gradually, as other fish often do, forsaking the place, were not to be killed so near the shore as before; but are now found, and have been so ever since, in the openings and spaces among the ice, where they have deep water, and where they go sometimes a great many leagues from the shore.

The whale fishery begins in May, and continues all June and July; but whether the ships have good or bad success they must come away and get clear of the ice by the end of August; so that in the month of September, at farthest, they may be expected home; but a ship that meets with a fortunate and early fishery in May, may return in June or July.

The manner of taking whales at present is as follows: as soon as the fishermen hear the whale blow, they cry out fall! fall! and every ship gets out its long-boat, in each of which there are six or seven men; they row till they come pretty near the whale, then the harpooner strikes it with the harpoon. This requires great dexterity, for through the bone of his head there is no striking, but near his spout there is a soft piece of flesh, into which the iron sinks with ease. As soon as he is struck they take care to give him rope enough, otherwise when he goes down, as he frequently does, he would inevitably sink the boat: this rope he draws with such violence, that, if it were not well watered, it would by its friction against the sides of the boat be soon set on fire. The line fastened to the harpoon is six or seven fathoms long, and is called the fore-runner: it is made of the finest and softest hemp that it may slip the easier: to this they join a heap of lines of 90 or 100 fathoms each, and when there are not enough in one long boat they borrow from another. The man at the helm observes which way the rope goes, and steers the boat accordingly, that it may run exactly out before; for the whale runs away with the line with so much rapidity that he would overset the boat if it were not kept straight. When the whale is struck, the other long boats row before and observe which way the line stands, and sometimes pull it; if they feel it stiff it is a sign the whale still pulls in strength, but if it hangs loose and the boat lies equally high before and behind upon the water they pull it in gently, but take care to coil it so that the whale may have it again easily if he recovers strength: they take care, however, not to give him too much line, because he sometimes entangles it about a rock and pulls out the harpoon. The fat whales do not sink as soon as dead, but the lean ones do, and come up some days afterwards. As long as they see whales they lose no time in cutting up what they have taken, but keep fishing for others: when they see no more, or have taken enough, they begin with taking off the fat and whiskers in the following manner: the whale being lashed along side, they lay it on one side and put two ropes, one at the head and the other in the place of the tail, which, together with the fins, is struck off as soon as he is taken, to keep those extremities above water. On the off side of the whale are two boats to receive the pieces of fat, utensils, and men, that might otherwise fall into the water on that side. These precautions being taken, three or four men, with irons at their feet to prevent slipping, get on the whale, and begin to cut out pieces of about three feet thick and eight long, which are hauled up at the capstan or windlass. When the fat is all got off they cut off the whiskers of the upper jaw with an axe. Before they cut they are all lashed to keep them firm, which also facilitates the cutting, and prevents them from falling into the sea; when on board, five or six of them are bundled together and properly stowed, and after all is got off the carcase is turned adrift and devoured by the bears, who are very fond of it. In proportion as the large pieces of fat are cut off, the rest of the crew are employed in slicing them smaller, and picking out all the lean. When this is prepared they stow it under the deck, where it lies

till the fat of all the whales is on board; then cutting it still smaller they put it up in tubs in the hold, cramming them very full and close. Nothing now remains but to sail homewards, where the fat is to be boiled and melted down into train oil.

It were in vain to speak in this place of the advantages that may be derived to Great Britain from the whale fishery. We shall only remark that the legislature thinks that trade of so great importance as to grant a very considerable bounty for the encouragement of it; for every British vessel of 200 tons or upwards, bound to the Greenland Seas on the whale fishery, if found to be duly qualified according to the act, obtains a license from the commissioners of the customs to proceed on such voyage: and on the ship's return, the master and mate making oath that they proceeded on such voyage and no other, and used all their endeavours to take whales, &c. and that all the whale-fins, blubber, oil, &c. imported to their ship, were taken by their crew in those seas, there shall be allowed 40*s.* for every ton according to the admeasurement of the ship.

Besides these fisheries, there are several others both on the coasts of Great Britain and in the North Seas, which although not much the subject of merchandize, nevertheless employ great numbers both of ships and men; as, 1. The oyster fishing at Colchester, Feversham, the Isle of Wight, in the Swales of the Medway, and in all the creeks between Southampton and Chichester, from whence they are carried to be fed in pits about Wevenhoe and other places. See Oyster.

2. The lobster fishing all along the British channel, the firth of Edinburgh, on the coast of Northumberland, and on the coast of Norway, from whence great quantities are brought to London. And, lastly, the fishing of the pot-fish, fin-fish, sea-unicorn, sea-horse, and the seal, or dog-fish, all which are found in the same seas with the whales, and yield blubber in a certain degree; besides, the horn of the unicorn is as estimable as ivory, and the skins of the seals are particularly useful to trunk-makers.

FISHING, in general, the art of catching fish, whether by means of nets, or of spears, lines, rods, and hooks. See Angling.

FISTULA, in the ancient music, an instrument of the wind kind, resembling our flute, or flageolet. See Flute.

Fistula, in surgery, a deep, narrow, and callous ulcer, generally arising from abscesses. Fistulas differ from sinuses in this, that the former are callous, the latter not. See Surgery.

Fistula *luchrymalis*, a disease which attacks the great caruncle in the inward corner of the eye.

FISTULARIA, the *tobacco-pipe fish*, in natural history, a genus of fishes of the order Abdominales. Generic character: snout cylindrical; jaws distant from the eyes; gill membrane with seven rays; body tapering from the jaws to the tail. There are three species. F. tabacaria, or the slender fistularia, grows to the length of three feet, and is found on the coasts of Brazil, by the inhabitants of which it is eaten, though not particularly esteemed by them. It lives principally upon smaller fishes, insects, and worms. These it obtains with great ease, by means of a species of snout, which it introduces into clefts, and under stones, where they mostly abound. The two other species are natives of the Indian seas.

FITCHEE, in heraldry, a term applied to a cross, when the lower end of it is sharpened into a point.

FITS *of easy reflection*, &c. in optics. Sir Isaac Newton calls the successive disposition of a ray to be reflected through different thicknesses of a plate of air, or any other substance, the returns or fits of easy reflection, and the disposition of the same ray to be transmitted in the same manner through the intervening spaces, returns or fits of easy transmission. Thus, a ray of light is in a fit of easy reflection, when it falls on a plate of any kind of matter, whose thickness is one of the terms of the series 1, 3, 5, 7, &c. taking the smallest thickness capable of reflecting such ray for unit; and, in the same way, it is in one of its fits of easy transmission when the thickness is one of the terms of the series 2, 4, 6, 8, &c. See Optics.

FIXED *bodies* are those which bear a considerable degree of heat without evaporating, or losing any of their weight.

FIXITY. The property by which bodies resist the action of heat, so as not to rise in vapour. It is the opposite to volatility. The fixity of bodies appears to be merely relative, and depends on the temperature at which they assume the elastic state or form. Such bodies as assume this state at a low temperature will easily rise; whereas those which cannot be so dilated

but at an extreme heat will remain fixed in all ordinary situations. From the analogy of a variety of facts, it does not seem probable that any substances are absolutely fixed.

FLACOURTIA, in botany, so called in memory of Stephen de Flacourt, a genus of the Dioecia Polyandria class and order. Natural order of Tiliaceæ, Jussieu. Essential character: male, calyx five-parted; corolla none; stamens very numerous: female, calyx many-leaved; corolla none; germ superior; styles five to nine; berry many-celled. There is but one species.

FLAG, a general name for colours, standards, antients, banners, ensigns, &c. which are frequently confounded with each other. The fashion of pointed, or triangular flags, as now used, Rod. Toletan assures, came from the Mahometan Arabs, or Saracens, upon their seizing of Spain, before which time all the engines of war were stretched, or extended on cross pieces of wood, like the banners of a church. The pirates of Algiers, and throughout the coasts of Barbary, bear an hexagonal flag.

FLAG is more particularly used at sea; for the colours, antients, standards, &c. borne on the tops of the masts of vessels, to notify the person who commands the ship, of what nation it is, and whether it be equipped for war or trade. The admiral in chief carries his flag on the main-top; the vice-admiral on the fore-top; and the rear-admiral on the mizen-top. When a council of war is to be held at sea, if it be on board the admiral, they hang a flag in the main shrouds; if in the vice-admiral, in the fore shrouds; and if in the rear-admiral, in the mizen shrouds.

Besides the national flag, merchant ships frequently bear lesser flags on the mizen mast, with the arms of the city where the master ordinarily resides; and on the fore-mast, with the arms of the place where the person who freights them lives.

FLAG, *to lower or strike the*, is to pull it down upon the cap, or to take it in, out of the respect or submission due from all ships or fleets inferior to those any way justly their superiors. To lower or strike the flag, in an engagement, is a sign of yielding.

The way of leading a ship in triumph is to tie the flags to the shrouds, or the gallery, in the hind part of the ship, and let them hang down towards the water, and to tow the vessels by the stern. Livy relates, that this was the way the Romans used those of Carthage.

FLAG, *to heave out the*, is to put out or put abroad the flag.

FLAG, *to hang out the white*, is to ask quarter; or it shews when a vessel is arrived on a coast, that it has no hostile intention, but comes to trade, or the like. The red flag is a sign of defiance and battle.

FLAG *officers*, those who command the several squadrons of a fleet, such are the admirals, vice-admirals, and rear-admirals. The flag-officers in our pay are the admiral, vice-admiral, and rear-admiral, of the white, red, and blue.

FLAG *ship*, a ship commanded by a general or flag-officer, who has a right to carry a flag, in contradistinction to the secondary vessels under the command thereof.

FLAGELLARIA, in botany, a genus of the Hexandria Trigynia class and order. Natural order of Tripetaloideæ. Asparagi, Jussieu. Essential character: calyx six-parted; corolla none; berry one-seeded. There are two species.

FLAGEOLET, or FLAJEOLET, a little flute, used chiefly by shepherds and country people. It is made of box, or other hard wood, and sometimes of ivory, and has six holes besides that at the bottom, the mouth-piece, and that behind the neck. See FLUTE.

FLAIL, an instrument for thrashing corn. A flail consists of the following parts: 1. The hand-staff, or piece held in the thresher's hand. 2. The swiple, or that part which strikes out the corn. 3. The caplins, or strong double leathers, made fast to the tops of the hand-staff and swiple. 4. The middle-band, being the leather thong, or fish skin, that ties the caplins together.

FLAIR, in the sea language. When a ship is housed in near the water, so that the work above hangs over too much, it is said to flair over. This makes the ship more roomy aloft, for the men to use their arms.

FLAMBEAU, a kind of large taper, made of hempen wicks, by pouring melted wax on their top, and letting it run down to the bottom. This done, they lay them to dry; after which they roll them on a table, and join four of them together by means of a red-hot iron; and then pour on more wax, till the flambeau is brought to the size required. Flambeaus are of different lengths, and made either of white or yellow wax. They serve to give light in the streets at night, or on occasion of illuminations.

Fig. 1. **Felis** *Leopardus: Leopard — Fig. 2. F. Pardus: Panther*
Fig. 3. F. Tigris: Tiger — Fig. 4. F. Lynx.

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FLAME. Newton and others have considered flame as an ignited vapour, or red-hot smoke. This, in a certain sense, may be true, but, no doubt, it contains an inaccurate comparison. Simple ignition never exceeds in intensity of light the body by contact of which it was produced. But it appears to be well ascertained, that flame always consists of volatile inflammable matter, in the act of combustion and combination, with the oxgyen of the atmosphere. Many metallic substances are volatized by heat, and burn with a flame by the contact of the air in this rare state. Sulphur, phosphorus, and some other bases of acids, exhibit the same phenomenon. But the flames of organized substances are in general produced by the extrication and accension of hydrogen gas with more or less of charcoal. When the circumstances are not favourable to the perfect combustion of these products, a portion of the coal passes through the luminous current unburned, and forms smoke. Soot is the condensed matter of smoke.

As the artificial light of lamps and candles is afforded by the flame they exhibit, it seems a matter of considerable importance to society, to ascertain how the most luminous flame may be produced with the least consumption of combustible matter. There does not appear to be any danger of error in concluding, that the light emitted will be greatest when the matter is completely consumed in the shortest time. It is, therefore, necessary, that a stream of volatized combustible matter of a proper figure, at a very elevated temperature, should pass into the atmosphere with a certain determinate velocity. If the figure of this stream should not be duly proportioned; that is to say, if it be too thick, its internal parts will not be completely burned for want of contact with the air. If its temperature be below that of ignition, it will not burn when it comes into the open air. And there is a certain velocity at which the quantity of atmospherical air which comes in contact with the vapour will be neither too great nor too small; for too much air will diminish the temperature of the stream of combustible matter so much as very considerably to impede the desired effect, and too little will render the combustion languid.

We have an example of a flame too large in the mouths of the chimneys of furnaces, where the luminous part is merely superficial, or of the thickness of about an inch or two, according to circumstances, and the internal part, though hot, will not set fire to paper passed into it through an iron tube; the same defect of air preventing the combustion of the paper, as prevented the interior fluid itself from burning. And in the lamp of Argand we see the advantage of an internal current of air, which renders the combustion perfect by the application of air on both sides of a thin flame. So likewise a small flame is whiter and more luminous than a larger; and a short snuff of a candle giving out less combustible matter in proportion to the circumambient air, the quantity of light becomes increased to eight or ten times what a long snuff would have afforded.

FLAMINGO, a bird, otherwise called phœnicopterus. See Phœnicopterus.

FLAMSTEED (John), in biography, an eminent English astronomer, being indeed the first astronomer royal, for whose use the Royal Observatory was built at Greenwich, thence called Flamsteed House. He was born at Denby, in Derbyshire, the 19th of August, 1646. He was educated at the free school of Derby, where his father lived, and at fourteen years of age was afflicted with a severe illness, which rendered his constitution tender ever after, and prevented him then from going to the university, for which he was intended. He nevertheless prosecuted his school education with the best effect; and then, in 1662, on quitting the grammar-school, he pursued the natural bent of his genius, which led him to the study of astronomy, and closely perused Sacrobosco's book "De Sphæra," which fell in his way, and which laid the ground-work of all that mathematical and astronomical knowledge, for which he became afterwards so justly famous. He next procured other more modern books of the same kind, and among them, Street's "Astronomia Carolina," then lately published, from which he learned to calculate eclipses and the planets' places. Some of these being shewn to a Mr. Halton, a considerable mathematician, he lent him Riccioli's "Almagestum Novum," and Kepler's "Tabulæ Rudolphinæ," which he profited much by. In 1669, having calculated some remarkable eclipses of the moon, he sent them to Lord Brouncker, President of the Royal Society, which were greatly approved by that learned body, and procured him a letter of thanks from Mr. Oldenburg, their Secretary, and another from Mr. John Collins, with whom,

and other learned men, Mr. Flamsteed for a long time afterwards kept up a correspondence, by letters on literary subjects.

In 1670, his father observing he held correspondence with these ingenious gentlemen, advised him to take a journey to London, to make himself perfectly acquainted with them; an offer which he gladly embraced, and visited Mr. Oldenburg and Mr. Collins, who introduced him to Sir Jonas Moore, which proved the means of his greatest honour and preferment: he here got the knowledge and practice of astronomical instruments, as telescopes, micrometers, &c. On his return, he called at Cambridge, and visited Dr. Barrow, Mr. Isaac Newton, and other learned men there, and entered himself a student of Jesus College. In 1672, he extracted several observations from Mr. Gascoigne's and Mr. Crabtree's letters, which improved him greatly in dioptrics. In this year he made many celestial observations, which, with calculations of the appulses of the moon and planets to fixed stars for the year following, he sent to Mr. Oldenburg, who published them in the "Philosophical Transactions."

In 1673, Mr. Flamsteed wrote a small tract concerning the true diameters of all the planets, when at their greatest and least distances from the earth, which he lent to Mr. Newton in 1685, who made some use of it in the fourth book of his "Principia." In 1674, he wrote an ephemeris to shew the falsity of astrology, and the ignorance of those who pretended to it; with calculations of the moon's rising and setting; also occultations and appulses of the moon and planets to the fixed stars. To which, at Sir Jonas Moore's request, he added a table of the Moon's southings for that year; from which, and from Philips's "Theory of the Tides," the high-waters being computed, he found the times come very near. In 1674 too, he drew up an account of the tides for the use of the King. Sir Jonas also shewed the King, and the Duke of York, some barometers and thermometers that Mr. Flamsteed had given him, with the necessary rules for judging of the weather; and otherwise took every opportunity of speaking favourably of Flamsteed to them, till at length he brought him a warrant to be the King's astronomer, with a salary of 100*l.* per annum, to be paid out of the office of ordnance, because Sir Jonas was then surveyor general of the ordnance. This, however, did not abate our author's propensity for holy orders, and he was accordingly ordained at Ely, by Bishop Gunning.

On the 10th of August 1675, the foundation of the Royal Observatory at Greenwich was laid; and, during the building of it, Mr. Flamsteed's temporary observatory was in the Queen's house, where he made his observations of the appulses of the moon and planets to the fixed stars, and wrote his "Doctrine of the Sphere," which was afterwards published by Sir Jonas, in his "System of Mathematics."

About the year 1684, he was presented to the living of Burslow in Surry, which he held as long as he lived. Mr. Flamsteed was equally respected by the great men his contemporaries, and by those who have succeeded since his death. Dr. Wotton, in his "Reflections upon Ancient and Modern Learning," styles our author one of the most accurate observers of the planets and stars, and says he calculated tables of the eclipses of the several satellites, which proved very useful to the astronomers: and Mr. Molyneux, in his "Dioptrica Nova," gives him a high character; and in the admonition to the reader, prefixed to the work, observes, that the geometrical method of calculating a ray's progress, is quite new, and never before published; and for the first hint of it, says he, I must acknowledge myself obliged to my worthy friend Mr. Flamsteed.

He wrote several small tracts, and had many papers inserted in the "Philosophical Transactions," *viz.* several in almost every volume, from the fourth to the twenty-ninth, too numerous to be mentioned in this place particularly.

But his great work, and that which contained the main operations of his life, was the "Historia Cœlestis Britannica," published in 1725, in three large folio volumes; the first of which contains the observations of Mr. William Gascoigne, the first inventor of the method of measuring angles in a telescope, by means of screws, and the first who applied telescopical sights to astronomical instruments, taken at Middleton, near Leeds in Yorkshire, between the years 1638 and 1643; extracted from his letters by Mr. Crabtree, with some of Mr. Crabtree's observations about the same time; and also those of Mr. Flamsteed himself, made at Derby, between the years 1670 and 1675; besides a multitude of curious observations, and necessary tables, to be used with them, made at the Royal Ob-

servatory, between the years 1675 and 1689. The second volume contains his observations, made with a mural arch of near 7 feet radius, and 140 degrees on the limb, of the meridional zenith, distances of the fixed stars, sun, moon, and planets, with their transits over the meridian; also observations of the diameters of the sun and moon, with their eclipses, and those of Jupiter's satellites, and variations of the compass from 1689 to 1719, with tables shewing how to render the calculation of the places of the stars and planets easy and expeditious; to which are added, the moon's place at her oppositions, quadratures, &c.; also the planets' places, derived from the observations. The third volume contains a catalogue of the right ascensions, polar distances, longitudes, and magnitudes of near 3,000 fixed stars, with the corresponding variations of the same: to this volume is prefixed a large preface, containing an account of all the astronomical observations made before his time, with a description of the instruments employed, as also of his own observations and instruments, with a new Latin version of Ptolemy's "Catalogue of 1026 fixed stars," and Ulegh-beig's "Places" annexed on the Latin page, with the corrections; a small catalogue of the Arabs; Tycho Brahe's of about 780 fixed stars; the Landgrave of Hesse's of 386; Helvetius's of 1534; and a catalogue of some of the southern fixed stars, not visible in our hemisphere, calculated from the observations made by Dr. Halley at St. Helena, adapted to the year 1726.

This work he prepared in a great measure for the press, with much care and accuracy; but through a natural weakness of constitution, and the decline of age, he died of a stranguary before he had finished it, December the 19th, 1719, at 73 years of age, leaving the care of finishing and publishing his work to his friend Mr. Hodgson. A less perfect edition of the Historia Cœlestis had before been published without his consent, *viz.* in 1712, in one volume folio, containing his observations to the year 1705.

Thus then, as Dr. Keil observed, our author for more than forty years watched the motion of the stars, and has given us innumerable observations of the sun, moon, and planets, which he made with very large instruments, accurately divided, and fitted with telescopic sights; whence we may rely much more on the observations he has made than on those of former astronomers, who made their observations with the naked eye, and without the like assistance of telescopes.

FLANKS *of an army*, are the troops encamped on the right and left, as the flanks of a battalion are the files on the right and left.

FLANK *of a bastion*, in fortification, that part which joins the face to the curtain.

FLANNEL, a kind of woollen stuff, composed of a woof and warp, and woven after the manner of baise. Various theories have been adopted to prove the utility of flanne as an article of dress: it is unquestionably a bad conductor of heat, and on that account very useful in cold weather; this is accounted for from the structure of the stuff; the fibres touch each other very slightly, so that the heat moves slowly through the interstices, which being already filled with air, give little assistance in carrying off the heat. On this subject Count Rumford has made many experiments, from which it should seem, that though linen, from the apparent ease with which it receives dampness from the atmosphere, appears to have a much greater attraction for water than any other, yet that those bodies which receive water in its unelastic form with the greatest ease, or are most easily wet, are not those which in all cases attract the moisture of the atmosphere with the greatest avidity. "Perhaps," says he, "the apparent dampness of linen to the touch arises more from the ease with which that substance parts with the water it contains, than from the quantity of water it actually holds; in the same manner as a body appears hot to the touch in consequence of its parting freely with its heat, while another body, which is really at the same temperature, but which withholds its heat with great obstinacy, affects the sense of feeling much less violently. It is well known that woollen clothes, such as flannels, &c. worn next the skin, greatly promote insensible perspiration. May not this arise principally from the strong attraction which subsists between wool and the watery vapour which is continually issuing from the human body? That it does not depend entirely on the warmth of that covering is clear; for the same degree of warmth produced by wearing more clothing of a different kind does not produce the same effect. The perspiration of the human body being absorbed by a covering of flannel, it is immediately distributed through the whole thickness of that substance, and by that means exposed by a

very large surface to be carried off by the atmosphere; and the loss of this watery vapour which the flannel sustains on the one side, by evaporation, being immediately restored from the other, in consequence of the strong attraction between the flannel and this vapour, the pores of the skin are disencumbered, and they are continually surrounded by a dry and salubrious atmosphere." He expresses his surprise, that the custom of wearing flannel next the skin should not have prevailed more universally. He is confident it would prevent a number of diseases; and he thinks there is no greater luxury than the comfortable sensation which arises from wearing it, especially after one is a little accustomed to it. "It is a mistaken notion," says he, "that it is too warm a clothing for summer. I have worn it in the hottest climates, and at all seasons of the year; and never found the least inconvenience from it. It is the warm bath of perspiration confined by a linen shirt, wet with sweat, which renders the summer heats of southern climates so insupportable; but flannel promotes perspiration, and favours its evaporation; and evaporation, as is well known, produces positive cold."

FLAT, in the sea-language. To flat in the fore-sail, is to hail it in by the sheet, as near the ship's side as possible; which is done, when a ship will not fall off from the wind.

FLATS, in music, a kind of additional notes, which, together with sharps, serve to remedy the defects of musical instruments, wherein temperament is required.

FLATTING, in gilding, is the giving the work a light touch, in the places not burnished, with a pencil dipt in size, in which a little vermilion is sometimes mixt. This serves to preserve and prevent its flawing when handled. See GILDING.

FLATULENCY. See MEDICINE.

FLAX. See LINUM.

Flax is an excellent commodity, and the cultivation of it a good piece of husbandry. It will thrive in any sound land, but that which has lain long fallow is best; which being well ploughed, and laid flat and even, the seeds must be sown in a warm season, about the middle or end of March, or at farthest the beginning of April; and if a wet season happen, weeding will be necessary. The best seed is that brought from the East country, which, though dear, yet easily repays the charge: this will last two or three crops, when it is adviseable to renew the seeds again. Of the best seed, two bushels may serve for an acre; but more must be allowed of home-seed, because it grows smaller. When grown up, it ought not to be gathered before it be fully ripe; for if pulled before the blossom falls, it hackles away almost to nothing; and, though in appearance very fine, yet it has no substance, and the yarn spun of it is weak and ouzy: it not only wastes in the washing, but the linen made of it grows extremely thin in the bleaching. The pluckers should be nimble, tie it up in handfuls, set them up till perfectly dry, and then house them. Flax pulled in the bloom proves whiter and stronger than if left standing till the seed is ripe; but then the seed will be lost.

FLAX, *dressing of*. When flax has been watered, and twice swingled, it is then to be heckled in a much finer heckle than that used for hemp. Hold the strike of flax stiff in your hand, and break it very well upon the coarse heckle; saving the hurds to make harder cloth of. This done, the strike is to be passed through a finer heckle, and the hurds coming from thence saved for middling cloth, and the tare itself for the best linen.

But to dress flax for the finest use of all, after being handled as before, and laying three strikes together, plat them in a plat of three rows, as hard and close together as you can; joining one to the end of another, till you have platted as much as you think convenient: then begin another plat, and add as many several ones as you think will make a roll; afterwards wreathing them hard together, make up the roll; which done, put as many as you judge convenient into a hemp-trough, and beat them soundly, rather more than less than you do hemp. Next open and unplat them, dividing each strike very carefully from each other; and so strike it through the finest heckle of all, whereof there are three sorts. Great care must be taken to do this gently and lightly, lest what is heckled from thence should run to knots; for if preserved soft like cotton, it will make very good linen, each pound running at least two yards and an half. The tear itself, or finest flax, will make a strong and very fine holland, running at least five yards in the pound.

FLEA. See PULEX.

FLEAM, in surgery and farriery, an instrument for letting a horse blood. A case of fleams, as it is called by farriers, comprehends six sorts of instruments; two hooked ones, called drawers, and used for cleaning wounds; a pen-knife; a sharp-

pointed lancet, for making incisions; and two fleams, one sharp and the other broad-pointed. These last are somewhat like the point of a lancet, fixed in a flat handle, only no longer than is just necessary to open the vein.

FLEECE, the covering of wool, shorn off the bodies of sheep. See WOOL.

FLEECY *hosiery*, a very useful kind of manufacture of late invention, in which fine fleeces of wool are interwoven into a cotton piece of the common stocking texture: the nature of the manufacture is thus described, having in the common stocking frame, twitted silk, cotton-yarn, &c. begin the work in the common way of making hosiery, and having worked one or more course or courses in the usual method, begin to add a coating thus: draw the frame over the arch, and then hang wool or jersey, raw or unspun, upon the beards of the needles, and slide the same off their beards upon their stems, till it comes exactly under the nibs of the sinkers; then sink the jacks and sinkers, and bring forward the frame, till the wool or jersey is drawn under the beards of the needles; and having done this, draw the frame over the arch, and place a thread of spun materials upon the needles, and proceed in finishing the course in the usual way of manufacturing hosiery with spun materials. Any thing manufactured in this way has, on the one side, the appearance of common hosiery, and on the other side the appearance of raw wool.

FLEET, commonly implies a company of ships of war, belonging to any prince or state: but sometimes it denotes any number of trading ships, employed in any particular branch of commerce.

In sailing, a fleet of men of war is usually divided into three squadrons; the admiral's, the vice-admiral's, and the rear-admiral's squadron; all which, being distinguished by their flags and pendants, are to put themselves, and, as near as may be, to keep themselves in their customary places, *viz.* The admiral, with his squadron, to sail in the van, that so he may lead the way to all the rest in the day-time, by the sight of his flag in the main-top-mast-head; and in the night-time, by his lights or lanterns. The vice-admiral and his squadron, is to sail in the centre, or middle of the fleet, the rear-admiral, and the ships of his squadron, to bring up the rear. But sometimes other divisions are made, and those composed of the lighter ships and best sailors, are placed as wings to the van, centre, and rear.

Merchant-fleets generally take their denomination from the place they are bound to, as the Turkey fleet, East India fleet, &c. These, in time of peace, go in fleets for their mutual aid and assistance: in time of war, besides this security, they likewise procure convoys of men of war, either to escort them to the places whither they are bound, or only a part of the way, to a certain place or latitude, beyond which they are judged out of danger of privateers, &c. See CONVOY.

FLESH. See ANATOMY.

FLEXION, in anatomy, is applied to the motion by which the arm or any other member of the body is bent. It is also applied to the muscles, nerves, &c.

FLEXION, or *flexure of curves.* See FLEXURE.

FLEXOR, in anatomy, a name applied to several muscles, which are so called from their office, which is to bend the part to which they belong, in opposition to the extensors, which open or stretch them. See ANATOMY.

FLEXURE *of curves*, in the higher geometry, is used to signify that a curve is both concave and convex, with respect to a given right line or a fixed point.

FLIGHT, in law. On an indictment of treason, felony, or even petit-larceny, if the jury find that the party fled for it, he shall forfeit his goods and chattels, though he is acquitted of the offence; but the jury seldom find the flight, it being thought too severe a punishment for that to which a man is prompted by his natural love of liberty.

FLINT. A semitransparent hard stone, of the siliceous order, of a greyish, black, or yellowish colour, well known for its general utility in giving fire with the steel. It is commonly found in nodules, in beds of chalk or sand, and frequently exhibits indications of its having been in a soft state. Some specimens are hollow, and internally lined with siliceous crystals. By long exposure on the surface of the ground, they gradually become white on their upper surface first, and afterwards all over. This whiteness, in process of time, penetrates into the substance of the flint, forming a crust sometimes one-twentieth of an inch thick, which may be scraped with a knife. It has been said, that this is a conversion of flint into calcareous earth; but we know of no proof of the fact; and as this white matter does not appear to be affected by nitric acid, we are inclined to think, that the flint is merely shattered by the weather in a manner somewhat analogous to the effect of ignition and quenching in water, which renders it white and friable.

Weigleb found the common flint to contain 80 parts in the 100 silex, 18 alumina, and 2 lime. It is used in making glass and pottery.

A solution of siliceous earth, made by fusing flints with a large proportion of fixed alkali, and dissolving the mass in water, is called liquor of flints.

FLOAT *of a fishing-line*, the cork or quill that floats or swims above water. See ANGLING.

FLOAT also signifies a certain quantity of timber bound together with rafters, athwart, and put into a river to be conveyed down the stream; and even, sometimes, to carry burdens down a river with the stream.

FLOAT *boards*, those boards fixed to water-wheels of under-shot mills, serving to receive the impulse of the stream, whereby the wheel is carried round. See MILL.

FLOATING *bodies* are those which swim on the surface of a fluid, the most interesting of which are ships and vessels employed in war and commerce. It is known to every seaman, of what vast moment it is to ascertain the stability of such vessels, and the positions they assume when they float freely on the surface of the water. To be able to accomplish this, it is necessary to understand the principles on which that stability and these positions depend. A floating body is pressed downwards by its own weight in a vertical line passing through its centre of gravity; and it is supported by the upward pressure of a fluid, which acts in a vertical line that passes through the centre of gravity of the part which is under the water; and without a coincidence between these two lines, in such a manner as that both centres of gravity may be in the same vertical line, the solid will turn on an axis, till it gains a position in which the equilibrium of floating will be permanent. From this it is obviously necessary to find what proportion the part immersed bears to the whole, to do which the specific gravity of the floating body must be known, after which it must be found by geometrical method, in what positions the solid can be placed on the surface of the fluid, so that both centres of gravity may be in the same vertical line, when any given part of the solid is immersed under the surface. These things being determined, something is still wanting, for positions may be assumed in which the circumstances now mentioned concur; and yet the solid will assume some other position wherein it will permanently float. However operose and difficult (says an able mechanic) the calculations necessary to determine the stability of nautical vessels may, in some cases be, yet they all depend upon the four following simple and obvious theorems, accompanied with other well known stereometrical and statical principles.

Theorem 1. Every floating body displaces a quantity of the fluid in which it floats, equal to its own weight; and consequently, the specific gravity of the fluid will be to that of the floating body, as the magnitude of the whole is to that of the part immersed.

Theorem 2. Every floating body is impelled downward by its own essential power, acting in the direction of a vertical line passing through the centre of gravity of the whole; and is impelled upward by the re-action of the fluid which supports it, acting in the direction of a vertical line passing through the centre of gravity of the part immersed; therefore, unless these two lines are coincident, the floating body thus impelled must revolve round an axis, either in motion or at rest, until the equilibrium is restored.

Theorem 3. If by any power whatever a vessel be deflected from an upright position, the perpendicular distance between two vertical lines passing through the centres of gravity of the whole, and of the part immersed respectively, will be as the stability of the vessel, and which will be positive, nothing, or negative, according as the metacentre is above, coincident with, or below the centre of gravity of the vessel.

Theorem 4. The common centre of gravity of any system of bodies being given in position, if any one of these bodies be moved from one part of the system to another, the corresponding motion of the common centre of gravity, estimated in any given direction, will be to that of the aforesaid body, estimated in the same direction, as the weight of the body moved is to that of the whole system. From whence it is evident, that in order to ascertain the stability of any vessel, the position of the centres of gravity of the whole, and of that part immersed, must be determined; with which, and the dimensions of the vessel, the line of floatation, and angle of deflection, the stability or power either to right itself or overturn, may be found.

FLOOD, among seamen, is when the tide begins to come up, or the water begins to rise, then they call it young flood; after

which it is a quarter flood, half flood, and and high flood. See Tide.

Flood *mark*, the mark which the sea makes on the shore, at flowing water, and the highest tide: it is also called high-water-mark.

FLOOR. The lower part of a mine is called the floor, and the upper the roof.

FLORENTINE *work*. When Italy, many years past, enjoyed a state of perfect tranquillity, and the minds of all ranks of the inhabitants were under the influence of religious enthusiasm, the different orders of religious, the priests, and the nobles, each endeavoured to excel the other in the splendid decorations of churches, altars, and shrines; the arts of the architect, the sculptor, and the painter were exhausted, and the pious almost at a loss how to dispose of their riches in honour of their numerous patron-saints. Mosaic work had been invented many centuries, but some ingenious person, disdaining the comparative ease of that beautiful and expensive manner of imitating paintings, thought of Florentine work, which is performed by inserting fragments of precious stones in cement, so as to represent any subject usually treated by the pencil.

Keysler mentions a Carthusian monastery, situated between Milan and Pavia, of uncommon magnificence: "the greatest part of the altars in the church, are adorned with elegant representations of birds, flowers, &c. in the Florentine manner, performed by the artful position of precious stones inlaid in the marble. The convent entertains two excellent artists, a father and son, to perform these elegant works. The son, Valieri Sac, is so eminent in these performances, that the greatest mistress of embroidery would find it difficult to equal with her needle and silk, the variety of colours and shades which he expresses by sparks of agate, ruby, amethyst, cornelian, jasper, lapis-lazuli, and other precious stones. The high altar-piece, together with the tables on each side, are entirely of this Florentine work."

The Fabrica Degli Uffici, erected at Florence by Cosmo I., was appropriated in part for the reception of various artists, who worked exclusively for the Grand Duke. "But among all the performances executed here," says Keysler, "that styled Florentine work is the most elegant; sparks of precious stones, and particles of elegant marble, are so disposed as to represent the objects of nature in a very beautiful and surprising manner; but works of this kind require a prodigious time to complete them. A flower-piece lately finished, about a foot and a half in length, and half a foot in breadth, employed the artist above eighteen months; and a piece of embossed work, about the size of a common sheet of paper, representing the adoration of the Eastern magi, and a group of angels in the air, has already been forty years in hand, and under the direction of several masters."

The late unhappy state of Italy, and the probability of still further changes, has been so fatally destructive of the arts, that Florentine work will not soon be encouraged; and there is little doubt this laborious art will be almost lost.

FLORIN is sometimes used for a coin, and sometimes for a money of account. See Coin.

FLORY, Flowry, or Fleury, in heraldry, a cross that has the flowers at the end circumflex and turning down, differing from the potence, inasmuch as the latter stretches out more like that which is called patee.

FLOTILLA, a name given to a number of ships which get before the rest in their return, and give information of the departure and cargo of the flota and galleons.

FLOUR, the meal of wheat-corn, finely ground and sifted. Flour, when carefully analyzed, is found to be composed, 1, of fecula, which is insoluble in cold water, but soluble in hot water; 2, of gluten; 3, of a saccharine matter, susceptible of the spirituous fermentation.

FLOWER, in botany. By this term, former botanists, as Ray and Tournefort, &c., evidently meant the petals, or beautiful coloured leaves of the plant, which generally adhere to the seed-bud, or rudiment of the fruit. Since the introduction of the sexual method, the petals have lost their importance, and are now only considered as a finer sort of cover, which is generally present, but not essentially necessary to the existence of a flower. A flower then, in modern botany, is as different in meaning from the same term in former writers, as from the vulgar acceptations of the word at this day. The petals, the calyx, nay, the threads or filaments of the stamina may all be wanting, yet it is a flower still, provided the anthers, or male organ; and the stigma or summit of the style, the female organ, can be traced; and that either immediately in the neighbourhood of one another, as in most plants; on different parts of the same plant, as in the class Monoecia or on different plants raised from the same

seed, as in the class Dioecia. In this manner is to be understood the general principle with which the sexual method sets out, that every vegetable is furnished with flower and fruit. The essence of the flower, therefore, consists in the anthers and stigma, which constitute a flower, whether the covers, that is, the calyx and petals, are present or not.

Flower *de luce*. See Iris.

Flower *de lis*, or Flower *de luce*, in heraldry, a bearing representing the lily, called the queen of flowers, and the true hieroglyphic of royal majesty; but of late it is become more common, being borne in some coats one, in others three, in others five, and in some semee, or spread all over the escutcheon in great numbers.

Flowers, in chemistry, a term formerly applied to a variety of substances procured by sublimation, and were in the form of slightly cohering powder: hence, in all old books, we find mention made of the flowers of antimony, arsenic, zinc, and bismuth, which are the sublimed oxides of these metals, either pure, or combined with a small quantity of sulphur: we have also still in use, though not generally, the terms flowers of sulphur, benzoin, &c.

FLUATES, in chemistry, salts of which the Fluoric acid (which see) is the chief ingredient. Fluor spar, denominated fluate of lime, which is found in great plenty in many countries, and is very abundant in Derbyshire, where it obtains the name of Derbyshire spar, is the most important among the fluates. The chief properties of these salts are, 1. When sulphuric acid is poured upon them, they emit acrid vapours of fluoric acid, which corrode glass. 2. When heated, several of them phosphoresce. 3. They are not decomposed by heat, nor altered by combustibles. 4. They combine with silica by means of heat.

FLUENT, in fluxions, the flowing quantity, or that which is continually either increasing or decreasing, whether line, surface, solid, &c. See Fluxion.

FLUID, in physiology, an appellation given to all bodies whose particles easily yield to the least partial pressure or force impressed.

All fluids, except those in the form of air or gas, are incompressible in any considerable degree. The Academy del Cimento, from the following experiment, supposed water to be totally incompressible. A globe made of gold, which is less porous than any other metal, was completely filled with water and then closed up; it was afterwards placed under a great compressive force, which pressed the fluid through the pores of the metal, and formed a dew all over its surface, before any indent could be made in the vessel. Now, as the surface of a sphere will contain a greater quantity than the same surface under any other form whatever, the academy supposed that the compressive power which was applied to the globe must either force the particles of the fluid into closer adhesion, or drive them through the sides of the vessel before any impression could be made on its surface; for although the latter effect took place it furnishes no proof of the incompressibility of water, as the Florentines had no method of determining that the alteration of figure in their globe of gold occasioned such a diminution of its internal capacity, as was exactly equal to the quantity of water forced into its pores; but this experiment serves to shew the great minuteness of the particles of a fluid in penetrating the pores of gold, which is the densest of all metals. Mr. Canton brought the question of incompressibility to a more decisive determination. He procured a glass-tube, of about two feet long, with a ball at one end, of an inch and a quarter in diameter: having filled the ball and part of the tube with mercury, and brought it to the heat of 50° of Farenheit's thermometer, he marked the place where the mercury stood, and then raised the mercury by heat to the top of the tube, and there sealed the tube, hermetrically; then upon reducing the mercury to the same degree of heat as before, it stood in the tube $\frac{32}{100}$ of an inch higher than the mark. The same experiment was repeated with water, exhausted of air, instead of mercury, and the water stood in the tube $\frac{43}{100}$ above the mark. Now, since the weight of the atmosphere on the outside of the ball, without any counterbalance from within, will compress the ball, and equally raise both the mercury and water; it appears that the water expands $\frac{11}{100}$ of an inch more than the mercury, by removing the weight of the atmosphere. From this, and other experiments, he infers, that water is not only compressible but elastic; and that it is more capable of compressibility in winter than in summer.

All fluids gravitate, or weigh, in proportion to their quantity of matter, not only in the open air, or in vacuo, but in their own elements. Although this law seems so consonant to reason, it has been supposed by

ancient naturalists, who were ignorant of the equal and general pressure of all fluids, that the component parts, or the particles of the same element, did not gravitate or rest on each other; so that the weight of a vessel of water, balanced in air, would be entirely lost when the fluid was weighed in its own element. The following experiment seems to leave this question perfectly decided: take a common bottle, corked close, with some shot in the inside to make it sink, and fasten it to the end of a scale beam; then immerse the bottle in water, and balance the weight in the opposite scale; afterwards open the neck of the bottle and let it fill with water, which will cause it to sink; then weigh the bottle again. Now it will be found that the weight of the water which is contained in the bottle is equal to the difference of the weights in the scale, when it is balanced in air; which sufficiently shews that the weight of the water is the same in both situations. As the particles of fluids possess weight as a common property of bodies, it seems reasonable that they should possess the consequent power of gravitation which belongs to bodies in general. Therefore, supposing that the particles which compose fluids be equal, their gravitation must likewise be equal; so that, in the descent of fluids, when the particles are stopped and supported, the gravitation being equal, one particle will not have more propensity than another to change its situation, and after the impelling force has subsided the particles will remain at absolute rest.

From the gravity of fluids arises their pressure, which is always proportioned to the gravity. For if the particles of fluids have equal magnitude and weight, the gravity or pressure must be proportional to the depth, and equal in every horizontal line of fluid; consequently, the pressure on the bottom of vessels is equal in every part. The pressure of fluids upwards is equal to the pressure downwards at any given depth. For, suppose a column of water to consist of any given number of particles acting upon each other in a perpendicular direction, the first particle acts upon the second with its own weight only; and, as the second is stationary, or fixed by the surrounding particle, according to the third law of motion, that action and reaction are equal; it is evident that the action or gravity in the first is repelled in an equal degree by the reaction of the second; and in like manner, the second acts on the third, with its own gravity added to that of the first, but still the reaction increases in an equivalent degree, and so on throughout the whole depth of the fluid.

The particles of a fluid, at the same depth, press each other equally in all directions. This appears to rise out of the very nature of fluids, for as the particles give way to every impressive force, if the pressure amongst themselves should be unequal the fluid could never be at rest, which is contrary to experience; therefore, we conclude, that the particles press each other equally, which keeps them in their own places. This principle applies to the whole of a fluid as well as a part. For if four or five glass tubes, of different forms, be immersed in water, when the corks in the ends are taken out, the water will flow through the various windings of the different tubes, and rise in all of them to the same height as it stands in the straight tube: therefore the drops of fluids must be equally pressed in all directions during their ascent through the various angles of the tube, otherwise the fluid could not rise to the same height in them all.

From the mutual pressure and equal action of the particles of fluids, the surface will be perfectly smooth and parallel to the horizon. If from any exterior cause the surface of water has some parts higher than the rest, these will sink down by the natural force of their own gravitation, and diffuse themselves into an even surface. See HYDROSTATICS.

FLUIDS, *motion of*. The motion of fluids, *viz.* their descent or rise below or above the common surface or level of the source or fountain, is caused either, 1. By the natural gravity or pressure of the fluid contained in the reservoir, or fountain; or, 2. By the pressure or weight of the air on the surface of the fluid in the reservoir, when it is at the same time either taken off or diminished on some part in aqueducts, or pipes of conduit. 3. By the spring or elastic power of compressed or condensed air, as in the common water engine. 4. By the force of pistons, as in all kinds of forcing pumps, &c. 5. By the power of attraction, as in the case of tides, &c.

FLUIDITY. The state of bodies when their parts are very readily moveable in all directions with respect to each other. Many useful and curious properties arise out of this modification of matter, which form the basis of the mechanical science called hydrostatics, and are of considerable impor-

tance in chemistry. But the attention of the chemist is chiefly directed to the state of fluidity as it may affect the component parts of bodies.

A solid body may be converted into a fluid by heat. The less the temperature at which this is effected, the more fusible the body is said to be.

All fluids, not excepting the fixed metals, appear, from various facts, to be disposed to assume the elastic form, and this the more readily the higher the temperature. When a fluid is heated to such a degree as that its elasticity is equal to the pressure of the air, its interior parts rise up with ebullition.

The capacity of a dense fluid for caloric is greater than that of the same body when solid, but less than when in the elastic state. If this were not the case, the assumption of the fluid and elastic state would be scarcely at all progressive, but effected in most cases instantly as to sense. See CALORIC.

The state of dense fluidity appears to be more favourable to chemical combination than either the solid or elastic state. In the solid state, the cohesive attraction prevents the parts from obeying their chemical tendencies; and in the elastic state, the repulsion between the parts has, in a great measure, the same effects. Hence it has been considered, though too hastily, as a chemical axiom, that *corpora non agunt nisi fluida.*

FLUOR *spar*, the native fluate of lime. See the next article.

FLUORIC *acid*, in chemistry, is obtained from fluor spar, or, as it is technically called, fluate of lime. It has not yet been decomposed, unless it be among the grand discoveries of Mr. Davy, not yet announced to the world. We have attended the lectures of this professor, and think, in one of them, he said, he had decomposed the fluoric acid: for want, however, of any written document on the subject, we must content ourselves with a summary account of the properties of this acid, which were investigated with accuracy and precision by Scheele and Priestley. The spar was not distinguished from others of a similar appearance till about the year 1768, when Margraff attempted to decompose it by means of the sulphuric acid. He found that it consisted of a white sublimate, and a peculiar acid; the sublimate proved afterwards to be lime, and the acid being denominated fluoric acid; it is now called the fluate of lime. Margraff found, to his astonishment, that the glass retort in which the experiment had been made, was corroded, and even pierced with holes.

Fluoric acid may be obtained by putting a quantity of the spar in powder into a retort, pouring over it an equal quantity of sulphuric acid, and then applying a gentle heat. A gas ensues, which may be received in the usual manner, in jars, standing over mercury. This gas is the fluoric acid, which may be obtained dissolved in water, by luting to the retort a receiver containing that fluid. The distillation is to be conducted with a very moderate heat, to allow the gas to condense, and to prevent the fluor itself from subliming.

Soon after the discovery of this acid, it was doubted whether it possessed those properties that rendered it different from all other acids. Scheele, however, who had already investigated the subject, instituted another set of experiments, which completely established the fact.

The properties of this acid are, that, as a gas, it is invisible, and elastic like air: but it will not maintain combustion, nor can animals breathe it without death. In smell it is pungent, something similar to muriatic acid. It is heavier than common air, and corrodes the skin. When water is admitted in contact with this gas, it absorbs it rapidly; and if the gas be obtained by means of glass vessels, it deposits at the same time a quantity of silica. Water absorbs a large portion of this gas, and in that state it is usually called fluoric acid by chemists. It is then heavier than water, has an acid taste, reddens vegetable blues, and has the property of not congealing till cooled down to 23°. The pure acid may be obtained again from the compound by means of heat. Fluoric acid gas does not act upon any of the metals; but liquid fluoric acid is capable of oxyding iron, zinc, copper, and arsenic. It does not act upon the precious metals, nor upon platina, mercury, lead, tin, antimony, cobalt. It combines with alkalies, earths, and metallic oxides, and, with them, forms salts denominated fluates, of which the true fluor, Derbyshire spar, or fluate of lime, consists of

Lime	57
Fluoric acid	16
Water	27
	100

The most remarkable property is that already alluded to, *viz.* the facility with which it corrodes glass and siliceous bodies,

especially when hot, and the ease with which it holds silica in solution, even when in a state of gas. This affinity for silica is so great that the thickest glass vessels can withstand its action only a short time. The order of its affinities is,

Alumina	Potash
Ammonia	Silex
Barytes	Soda
Lime	Strontian.
Magnesia	

As fluoric acid produces an insoluble compound with lime, it may be employed to detect the presence of that earth when held in solution. Two or three drops only of the acid will cause a milky cloud or precipitate to appear, if any lime is present.

Fluoric acid has been applied to engraving or etching on glass, and was used, according to Beckman, nearly a century and a half ago for that purpose, by an artist at Nuremburg, who obtained it from digesting fluor spar in nitric acid. Since, however, the discoveries of Scheele and Priestley, it has been more generally used, and the art is performed by covering the glass with wax, and then that part where the figures are to appear is laid bare, and the whole is exposed for some time to the hot vapour of fluoric acid. This simple process is employed with great advantage in writing labels on glass vessels, and in graduating thermometers, &c. See Thomson's Chemistry.

FLUSTRA, in natural history, *horn-wrack*, a genus of worms, of the order Zoophyta. Animal a polype, proceeding from porous cells; stem fixed, foliaceous, membranaceous, consisting of numerous rows of cells united together, and woven like a mat. About eighteen species have been described.

FLUTE, an instrument of music, the simplest of all those of the wind kind. It is played on by blowing it with the mouth, and the tones or notes are changed by stopping and opening the holes disposed for that purpose along its side. The ancient fistulæ, or flutes, were made of reeds, afterwards of wood, and last of metal; but how they were blown, whether as our flutes, or as hautboys, does not appear.

Flute, *German*, is an instrument intirely different from the common flute. It is not, like that, put into the mouth to be played, but the end is stopt with a tampion or plug; and the lower lip is applied to a hole about two inches and a half, or three inches, distant from the end. This instrument is usually about a foot and a half long; rather bigger at the upper end than the lower; and perforated with holes, besides that for the mouth, the lowest of which is stopped and opened by the little finger's pressing on a brass, or sometimes a silver key, like those in hautboys, bassoons, &c. Its sound is exceedingly sweet and agreeable; and serves as a treble in a concert.

FLUX, a general term made use of to denote any substance or mixture added to assist the fusion of minerals. In the large way, limestone or fluor spar are used as fluxes; but in small assays, the method of the great operations is not always followed, though it would be very frequently of advantage to do so. The fluxes made use of in assays, or philosophical experiments, consist usually of alkalies, which render the earthy mixtures fusible, by converting them into glass; or else glass itself into powder.

Alkaline fluxes are either the crude flux, the white flux, or the black flux. Crude flux is a mixture of nitre and tartar, which is put into the crucible with the mineral intended to be fused. The detonation of the nitre with the inflammable matter of the tartar is of service in some operations; though generally it is attended with inconvenience, on account of the swelling of the materials, which may throw them out of the vessel, if proper care be not taken either to throw in only a little of the mixture at a time, or to provide a large vessel.

White flux is formed by projecting equal parts of a mixture of nitre and tartar, by moderate portions at a time, into an ignited crucible. In the detonation which ensues, the nitric acid is decomposed, and flies off with the tartarous acid, and the remainder consists of the potash in a state of considerable purity. This has been called fixed nitre.

Black flux differs from the preceding, in the proportion of its ingredients. In this the weight of the tartar is double that of the nitre; on which account the combustion is incomplete, and a considerable portion of the tartarous acid is decomposed by the mere heat, and leaves a quantity of coal behind, on which the black colour depends. It is used where metallic ores are intended to be reduced, and effects this purpose, by combining with the oxygen of the oxide.

There is danger of loss in the treatment of sulphureous ores with alkaline fluxes; for, though much or the greater part of the

 FLU

sulphur may be dissipated by roasting, yet that which remains will form a sulphuret with the alkali, which is a very powerful solvent of metallic bodies. The advantage of M. Morveau's reducing flux seems to depend on its containing no uncombined alkali. It is made of eight parts of pulverized glass, one of calcined borax, and half a part of powder of charcoal. Care must be taken to use a glass which contains no lead. The white glasses contain in general a large proportion, and the green bottle glasses are not perhaps entirely free from it.

Flux, in medicine, an extraordinary issue, or evacuation of some humours of the body. See Medicine.

FLUXION, in mathematics, denotes the velocity by which the fluents or flowing quantities increase or decrease; and may be considered as positive or negative, according as it relates to an increment or decrement.

The doctrine of fluxions, first invented by Sir Isaac Newton, is of great use in the investigation of curves, and in the discovery of the quadratures of curvilinear spaces, and their rectifications. In this method, magnitudes are conceived to be generated by motion, and the velocity of the generating motion is the fluxion of the magnitude. Thus, the velocity of the point that describes a line, is its fluxion, and measures its increase or decrease. When the motion of this point is uniform, its fluxion or velocity is constant, and may be measured by the space described in a given time, but when the motion varies the fluxion of velocity at any given point is measured by the space that would be described in a given time, if the motion was to be continued uniformly from that term.

Thus, let the point m be conceived to

A m m r

R

move from A, and generate the variable right line Am, by a motion any how regulated; and let its velocity, when it arrives at any proposed position or point R, be such as would, was it to continue uniform from that point, be sufficient to describe the line Rr, in the given time allotted for the fluxion, then will Rr be the fluxion of the variable line Am, in the term or point R.

The fluxion of a plain surface is conceived in like manner, by supposing a given right line mn (Plate V. Miscel. fig. 8) to move parallel to itself, in the plane of the parallel and moveable lines AF and BG: for if, as above, Rr be taken to express the fluxion of the line Am, and the rectangle RrsS be completed; then that rectangle, being the space which would be uniformly described by the generating line mn, in the time that Am would be uniformly increased by mr, is therefore the fluxion of the generated rectangle Bm, in that position.

If the length of the generating line mn continually varies, the fluxion of the area will still be expounded by a rectangle under that line, and the fluxion of the absciss or base: for let the curvilinear space Anm (fig. 9), be generated by the continual and parallel motion of the variable line mn; and let Rr be the fluxion of the base or absciss Am, as before, then the rectangle RrsS, will be the fluxion of the generated space Amn. Because, if the length and velocity of the generating line mn were to continue invariable from the position RS, the rectangle RrsS would then be uniformly generated with the very velocity wherewith it begins to be generated, or with which the space Amn is increased in that position.

Fluxions, *notation of*, of invariable quantities, or those which neither increase nor decrease, are represented by the first letters of the alphabet, as a, b, c, d, &c. and the variable or flowing quantities by the last letters, as, v, w, x, y, z: thus, the diameter of a given circle may be denoted by a; and the sine of any arch thereof, considered as variable, by x. The fluxion of a quantity represented by a single letter, is expressed by the same letter with a dot or full point over it: thus, the fluxion of x is represented by $\dot{x}$, and that of y by $\dot{y}$. And, because these fluxions are themselves often variable quantities, the velocities with which they either increase or decrease, are the fluxions of the former fluxions, which may be called second fluxions, and are denoted by the same letters with two dots over them, and so on to the third, fourth, &c. fluxions. The whole doctrine of fluxions consist in solving the two following problems, *viz*. From the fluent, or variable flowing quantity given, to find the fluxion; which constitutes what is called the direct method of fluxions. 2. From the fluxion given, to find the fluent, or flowing quantity; which makes the inverse method of fluxions.

Fluxions, *direct method of*, the doctrine

of this part of fluxions is comprized in these rules.

1. To find the fluxion of any simple variable quantity, the rule is to place a dot over it: thus, the fluxion of x is $\dot{x}$, and of y, $\dot{y}$. Again, the fluxion of the compound quantity $x + y$, is $\dot{x} + \dot{y}$; also the fluxion of $x - y$, is $\dot{x} - \dot{y}$.

2. To find the fluxion of any given power of a variable quantity, multiply the fluxion of the root by the exponent of the power, and the product by that power of the same root, whose exponent is less by unity than the given exponent. This rule is expressed more briefly, in algebraical characters, by $n x^{n-1} \dot{x} =$ the fluxion of x^{n}. Thus the fluxion of x^3 is $\dot{x} \times 3 \times x^2 = 3 x^2 \dot{x}$; and the fluxion of x^5 is $\dot{x} \times 5 \times x^4 = 5 x^4 \dot{x}$. In the same manner the fluxion of $\overline{a + y}|^7$ is $7 \dot{y} \times \overline{a + y}|^6$; for the quantity a being constant, $\dot{y}$ is the true fluxion of the root $a + y$ Again, the fluxion of $\overline{a^2 + z^2}|^{\frac{3}{2}}$ will be $\frac{3}{2} \times 2 z \dot{z} \times \overline{a^2 + z^2}|^{\frac{1}{2}}$: for here, x being put $= a^2 + z^2$, we have $\dot{x} = 2 z \dot{z}$; and therefore $\frac{3}{2} x^{\frac{1}{2}} \dot{x}$, for the fluxion of $x^{\frac{3}{2}}$ (or $\overline{a^2 + z^2}|^{\frac{3}{2}}$) is $= 3 z \dot{z} \sqrt{a^2 + z^2}$.

3. To find the fluxion of the product of several variable quantities, multiply the fluxion of each, by the product of the rest of the quantities; and the sum of the products, thus arising, will be the fluxion sought. Thus, the fluxion of $x y$ is $\dot{x} y + \dot{y} x$; that of $x y z$, is $\dot{x} y z + \dot{y} x z + \dot{z} x y$; and that of $v x y z$ is $\dot{v} x y z + \dot{x} v y z + \dot{y} v x z + \dot{z} v x y$. Again the fluxion of $\overline{a + x} \times \overline{b - y} = a b + b x - a y - x y$, is $b \dot{x} - a \dot{y} - \dot{x} y - \dot{y} x$.

4. To find the fluxion of a fraction, the rule is, from the fluxion of the numerator, multiplied by the denominator, subtract the fluxion of the denominator multiplied by the numerator, and divide the remainder by the square of the denominator. Thus, the fluxion of $\frac{x}{y}$, is $\frac{y \dot{x} - x \dot{y}}{y^2}$; that of $\frac{x}{x + y}$, is $\frac{\dot{x} \times \overline{x + y} - \overline{\dot{x} + \dot{y}} \times x}{\overline{x + y}|^2} = \frac{y \dot{x} - x \dot{y}}{\overline{x + y}|^2}$; and that of $\frac{x + y + z}{x + y}$, or $1 + \frac{z}{x + y}$, is $\frac{\dot{z} \times \overline{x + y} - \overline{\dot{x} + \dot{y}} \times z}{\overline{x + y}|^2}$; and so of others.

In the examples hitherto given, each is resolved by its own particular rule; but in those that follow, the use of two or more of the above rules is requisite: thus (by rule 2 and 3) the fluxion of $x^2 y^2$ is found to be $2 x^2 y \dot{y} + 2 y^2 x \dot{x}$; that of $\frac{x^2}{y^2}$, is found (by rule 2 and 4)] to be $\frac{2 y^2 x \dot{x} - 2 x^2 y \dot{y}}{y^4}$; and that of $\frac{x^2 y^2}{z}$, is (by rule 2, 3, and 4,) found to be $\frac{\overline{2 x^2 y \dot{y} + 2 y^2 x \dot{x}} \times z - x^2 y^2 \dot{z}}{z^2}$.

5. When the proposed quantity is affected by a coefficient, or constant multiplicator, the fluxion found as above must be multiplied by that coefficient or multiplicator: thus, the fluxion of $5 x^3$, is $15 x^2 \dot{x}$; for the fluxion of x^3 is $3 x^2 \dot{x}$, which, multiplied by 5, gives $15 x^2 \dot{x}$. And, in the very same manner, the fluxion of $a x^n$ will be $n a x^{n-1} \dot{x}$.

Hence it appears, that whether the root be a simple or a compound quantity, the fluxion of any power of it is found by the following general Rule:

Multiply by the index, diminish the index by unity, and multiply by the fluxion of the root. Thus the fluxion of $z^8 = 8 z^7 \dot{z}$: the fluxion of $4 x^6 = 24 x^5 \dot{x}$ and the fluxion of $\frac{3}{4} z^{\frac{4}{5}} = \frac{12}{20} z^{-\frac{1}{5}} \dot{z} = \frac{3 \dot{z}}{5 z^{\frac{1}{5}}}$.

Having explained the manner of determining the first fluxions of variable quantities, it is unncessary in a work of this kind to enter upon the second, third, &c. fluxions, we shall therefore proceed to

Fluxions, *inverse method of*, or the manner of determining the fluents of given fluxions.

If what is already delivered, concerning the direct method, be duly considered, there will be no great difficulty in conceiving the reasons of the inverse method: though the difficulties that occur in this last part, upon another account, are indeed vastly great. It is an easy matter, or not impossible at most, to find the fluxion of any flowing quantity whatever; but, in the inverse method, the case is quite otherwise; for, as there is no method for deducing the fluent from the fluxion *a priori*, by a direct investigation; so it is impossible to lay down rules for any other forms of fluxions, than those particular ones, that we know, from the direct me-

thod, belong to such and such kinds of flowing quantities: thus, for example, the fluent of $2x\dot{x}$ is known to be x^2; because, by the direct method, the fluxion of x^2 is found to be $2x\dot{x}$: but the fluent of $y\dot{x}$ is unknown, since no expression has been discovered that produces $y\dot{x}$ for its fluxion. Be this as it will, the following rules are those used by the best mathematicians, for finding the fluents of given fluxions.

1. To find the fluent of any simple fluxion, you need only write the letters without the dots over them: thus, the fluent of $\dot{x}$ is x, and that of $a\dot{x}+b\dot{y}$, is $ax+by$.

2. To assign the fluent of any power of a variable quantity, multiplied by the fluxion of the root; first divide by the fluxion of the root, add unity to the exponent of the power, and divide by the exponent so increased: for dividing the fluxion $nx^{n-1}\dot{x}$ by $\dot{x}$, it becomes nx^{n-1}; and adding 1 to the exponent $(n-1)$ we have nx^n; which, divided by n, gives x^n, the true fluent of $nx^{n-1}\dot{x}$. Hence, by the same rule, the fluent of $3x^2\dot{x}$ will be $=x^3$; that of $2x^5\dot{x}=\frac{x^6}{3}$; that of $y^{\frac{1}{2}}\dot{y}=\frac{2}{3}y^{\frac{3}{2}}$; that of $ay^{\frac{5}{3}}\dot{y}=\frac{3ay^{\frac{8}{3}}}{8}$; and that of $y^{\frac{m}{n}}\dot{y}=\frac{y^{\frac{m}{n}+1}}{\frac{m}{n}+1}=\frac{ny^{\frac{m+n}{n}}}{m+n}$; that of $\frac{a\dot{x}}{x^n}$, or $a\dot{x}x^{-n}=\frac{ax^{1-n}}{1-n}$; that of $\overline{a+z}|^3\times\dot{z}=\frac{\overline{a+z}|^4}{4}$; and that of $\overline{a^m+z^m}|^n\times z^{m-1}\dot{z}=\frac{\overline{a^m+z^m}|^{n+1}}{m\times\overline{n+1}}$

In assigning the fluents of given fluxions, it ought to be considered, whether the flowing quantity, found as above, requires the addition or subtraction of some constant quantity, to render it complete: thus, for instance, the fluent of $nx^{n-1}\dot{x}$ may be either represented by x^n or by $x\pm a$; for a being a constant quantity, the fluxion of $x^n\pm a$, as well as of x^n, is $nx^{n-1}\dot{x}$.

Hence it appears, that the variable part of a fluent only can be assigned by the common method, the constant part being only assignable from the particular nature of the problem. Now to do this, the best way is to consider how much the variable part of the fluent, first found, differs from the truth, when the quantity which the whole fluent ought to express, is equal to nothing; then that difference, added to, or subtracted from, the said variable part, as occasion requires, will give the fluent truly corrected. To make this plainer by an example or two, let $\dot{y}=\overline{a+x}|^3\times\dot{x}$. Here we first find $y=\frac{\overline{a+x}|^4}{4}$; but when $y=0$, then $\frac{\overline{a+x}|^4}{4}$ becomes $=\frac{a^4}{4}$; since x, by hypothesis, is then $=0$: therefore $\frac{\overline{a+x}|^4}{4}$ always exceeds y by $\frac{a^4}{4}$; and so the fluent, properly corrected, will be $y=\frac{\overline{a+x}|^4-a^4}{4}=a^3x+\frac{3a^2x^2}{2}+ax^3+\frac{x^4}{4}$. Again, let $\dot{y}=\overline{a^m+x^m}|^n\times x^{m-1}\dot{x}$: here we first have $y=\frac{\overline{a^m+x^m}|^{n+1}}{m\times\overline{n+1}}$; and making $y=0$, the latter part of the equation becomes $\frac{\overline{a^m}|^{n+1}}{m\times\overline{n+1}}=\frac{a^{mn+m}}{m\times\overline{n+1}}$; whence the equation or fluent, properly corrected, is $y=\frac{\overline{a^m+x^m}|^{n+1}-a^{mn+m}}{m\times\overline{n+1}}$.

Hitherto x and y are both supposed equal to nothing, at the same time; which will not always be the case: thus, for instance, though the sine and tangent of an arch are both equal to nothing, when the arch itself is so; yet the secant is then equal to the radius. It will therefore be proper to add some examples, wherein the value of y is equal to nothing, when that of x is equal to any given quantity a. Thus, let the equation $\dot{y}=x^2\dot{x}$, be proposed; whereof the fluent first found is $y=\frac{x^3}{3}$; but when $y=0$, then $\frac{x^3}{3}=\frac{a^3}{3}$, by the hypothesis; therefore the fluent, corrected, is $y=\frac{x^3-a^3}{3}$. Again, suppose $\dot{y}=x^n\dot{x}$; then will $y=\frac{x^{n+1}}{n+1}$; which, corrected, becomes $y=\frac{a^{n+1}-x^{n+1}}{n+1}$. And lastly, if $\dot{y}=\overline{c^3+bx^2}|^{\frac{1}{2}}\times x\dot{x}$; then, first, $y=\frac{\overline{c^3+bx^2}|^{\frac{3}{2}}}{3b}$: therefore the fluent corrected is $y=\frac{\overline{c^3+bx^2}|^{\frac{3}{2}}-\overline{c^3+ba^2}|^{\frac{3}{2}}}{3b}$.

3. To find the fluents of such fluxionary

expressions as involve two or more variable quantities, substitute, instead of such fluxion, its respective flowing quantity; and, adding all the terms together, divide the sum by the number of terms, and the quotient will be the fluent. Thus, the fluent of $\dot{x} y + \dot{y} x = \frac{x y + x y}{2} = \frac{2 x y}{2} = x y$; and the fluent of $\dot{x} y z + \dot{y} x z + \dot{z} y x = \frac{x y z + x y z + x y z}{3} = \frac{3 x y z}{3} = x y z$.

But it seldom happens that these kinds of fluxions, which involve two variable quantities in one term, and yet admit of known and perfect fluents, are to be met with in practice.

Having thus shewn the manner of finding such fluents as can be truly exhibited in algebraic terms, it remains now to say something with regard to those other forms of expressions involving one variable quantity only; which yet are so affected by compound divisors and radical quantities, that their fluents cannot be accurately determined by any method whatsoever. The only method with regard to these, of which there are innumerable kinds, is to find their fluents by approximation, which, by the method of infinite series, may be done to any degree of exactness. See SERIES.

Thus, if it were proposed to find the fluent of $\frac{a \dot{x}}{a - x}$, it becomes necessary to throw the fluxion into an infinite series, by dividing $a \dot{x}$ by $a - x$: thus, $a \dot{x} \div \overline{a - x} = \dot{x} + \frac{x \dot{x}}{a} + \frac{x^2 \dot{x}}{a^2} + \frac{x^3 \dot{x}}{a^3} + \frac{x^4 \dot{x}}{a^4} +$, &c. Now the fluent of each term of this series, may be found by the foregoing rules to be $x + \frac{x^2}{2 a} + \frac{x^3}{3 a^2} + \frac{x^4}{4 a^3} + \frac{x^5}{5 a^4} +$, &c.

In order to shew the usefulness of fluxions, we shall give an example or two. 1. Suppose it were required to divide any given right line A B into two such parts, A C, C B, that their products are rectangles, may be the greatest possible. Let A B $= a$, and let the part A C, considered as variable (by the motion of C towards B) be denoted by x. Then B C being $= a - x$, we have A C $\times$ B C $= a x - x x$, whose fluxion $a \dot{x} - 2 x \dot{x}$ being put $= 0$, we get $a \dot{x} = 2 x \dot{x}$; and, consequently, $x = \frac{1}{2} a$. Hence it appears that A C (or x) must be exactly one half of A B.

Ex. 2. To divide a given number a into two parts, x, y, so that $x^m y^n$ may be a maximum.

Since $x + y = a$, and $x^m y^n =$ max. the fluxion of each $= 0$, the former, because it is constant, and the latter, because it is a maximum; $\therefore \dot{x} + \dot{y} = 0$, and $m y^n x^{m-1} \dot{x} + n x^m y^{n-1} \dot{y} = 0$; hence, $\dot{x} = - \dot{y}$, and $\dot{x} = - \frac{n x^m y^{n-1} \dot{y}}{m y^n x^{m-1}} = - \frac{n x \dot{y}}{m y}$; therefore $- \dot{y} = - \frac{n x \dot{y}}{m y}$; or $m y = n x$, and $m : n :: x : y$. Now $y = \frac{n x}{m}$; $\therefore x + \frac{n x}{m} = a$, consequently $x = \frac{m a}{m + n}$; and $y \left(= \frac{n x}{m}\right) = \frac{n a}{m + n}$.

If $m = n$, the two parts are equal.

Cor. Hence, to divide a quantity a into three parts, x, y, z, so that $x y z$ may be a max. the parts must be equal. For suppose x to remain constant, and y, z, to vary; the product $y z$, and consequently $x y z$, will be greatest when $y = z$. Or if y remain constant, the product $x z$, and consequently $y x z$, will be greatest when $x = z$. Thus it appears that the parts must be equal. And in like manner it may be shewn, that whatever be the number of parts, they will be equal.

Ex. 3. Given $x + y + z = a$, and $x y^2 z^3$ a maximum, to find x, y, z.

As x, y, z, must have some certain determinate values to answer these conditions, let us suppose such a value of y to remain constant, whilst x and z vary till they answer the conditions, and then $\dot{x} + \dot{z} = 0$ and $z^3 \dot{x} + 3 x z^2 \dot{z} = 0$; hence, $\dot{x} = - \dot{z} = - \frac{3 x z^2 \dot{z}}{z^3} = - \frac{3 x \dot{z}}{z}$, $\therefore z = 3 x$. Now let us suppose the value of z to remain constant, and x and y to vary, so as to satisfy the conditions; then $\dot{x} + \dot{y} = 0$, $y^2 \dot{x} + 2 x y \dot{y} = 0$; hence, $\dot{x} = - \dot{y} = - \frac{2 x y \dot{y}}{y^2} = - \frac{2 x \dot{y}}{y}$, $\therefore y = 2 x$; substitute in the given equation, these values of y and z in terms of x, and $x + 2 x + 3 x = a$, or $6 x = a$ hence, $x = \frac{1}{6} a$; $\therefore y = \frac{1}{3} a$; $z = \frac{1}{2} a$. In like manner, whatever be the number of unknown quantities, make any one of them variable with each of the rest, and the values of each in terms of that one quantity will be obtained; and by substituting the values of each in terms of that one, in the given equation, you will get the value of

that quantity, and thence the values of the others.

Ex. 4. To inscribe the greatest parallelogram D F G I in a given triangle A B C, fig. 10.

Draw B H perpendicular to A C; put A C $= a$, B H $= b$, B E $= x$, then E H $= b - x$; and by similar triangles, $b : a :: x :$ D F $= \frac{a x}{b}$; hence, the area D F G I $= \frac{a x}{b} \times \overline{b - x} =$ max. or $x \times \overline{b - x} = b x - x^2 =$ max. $\therefore b \dot{x} - 2 x \dot{x} = 0$; hence, $x = \frac{1}{2} b$; therefore E H $= \frac{1}{2}$ B H.

Ex. 5. Let A B C represent a cone, A C the diameter of the base; to inscribe in it the greatest cylinder D F G I, fig. 11.

Put $p =, 78539$, &c., then since A C $= a$. B H $= b$. B E $= x \frac{p a^2 x^2}{b^2} =$ the area of the end D E F of the cylinder; hence, the content of the cylinder $= \frac{p a^2 x^2}{b^2} \times \overline{b - x} =$ max. or $x^2 \times \overline{b - x} = b x^2 - x^3 =$ max. $\therefore 2 b x \dot{x} - 3 x^2 \dot{x} = 0$; hence, $x = \frac{2}{3} b$; therefore E H $= \frac{1}{3}$ B H. See Cylinder.

Ex. 6. To inscribe the greatest parallelogram D F G I in a given parabola A B C, fig. 11.

Put B H $= a$, $p =$ the parameter, $x =$ B E; then by the property of the parabola, D E$^2 = p x$, $\therefore$ D E $= p^{\frac{1}{2}} x^{\frac{1}{2}}$, and D F $= 2 p^{\frac{1}{2}} x^{\frac{1}{2}}$; hence, the area D F G I $= 2 p^{\frac{1}{2}} x^{\frac{1}{2}} \times \overline{a - x} =$ max. or $x^{\frac{1}{2}} \times \overline{a - x} = a x^{\frac{1}{2}} - x^{\frac{3}{2}} =$ max. $\therefore \frac{1}{2} a x^{-\frac{1}{2}} \dot{x} - \frac{3}{2} x^{\frac{1}{2}} \dot{x} = 0$; hence, $\frac{a}{x^{\frac{1}{2}}} = 3 x^{\frac{1}{2}}$, or $a = 3 x$, $\therefore x = \frac{1}{3} a$; consequently E H $= \frac{2}{3}$ B H.

Ex. 7. To cut the greatest parabola D E F from a given cone A B C, fig. 12.

Let A G C be that diameter of the base which is perpendicular to D G F; now E G is parallel to A B; put A C $= a$, A B $= b$, C G $= x$, then A G $= a - x$; and by the property of the circle D G $= \sqrt{a x - x^2}$, $\therefore$ D F $= 2 \sqrt{a x - x^2}$; also, by sim. $\triangle s$, $a : b :: x :$ G E $= \frac{b x}{a}$; hence, we have the area of the parabola $= \frac{2}{3} \times \frac{b x}{a} \times 2 \sqrt{a x - x^2} =$ max. hence, $x \sqrt{a x - x^2} =$ max. or $x^2 \times \overline{a x - x^2} = a x^3 - x^4 =$ max. $\therefore 3 a x^2 \dot{x} - 4 x^3 \dot{x} = 0$, and $3 a = 4 x$, $\therefore x = \frac{3}{4} a$. See Simpson's and Vince's Fluxions.

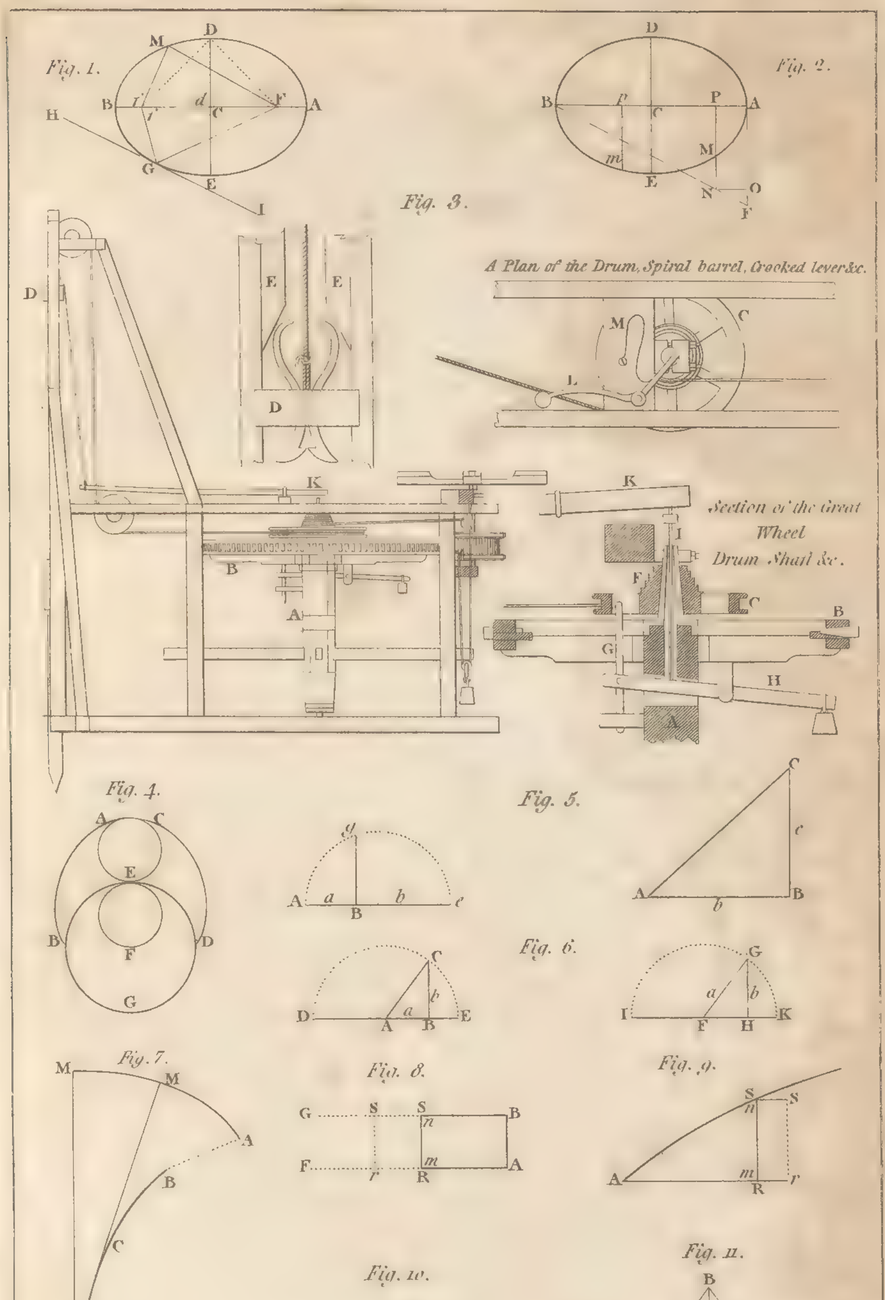
FLY, in zoology, a large order of insects, the distinguishing characteristic of which is, that their wings are transparent; by this they are distinguished from beetles, butterflies, and grasshoppers. See Entomology and Musca. Flies are subdivided into those which have four, and those which have two wings.

Fly, in mechanics, a cross with leaden weights at its ends, or rather a heavy wheel at right angles to the axis of a windlas, jack, or the like; by means of which the force of the power, whatever it be, is not only preserved, but equally distributed in all parts of the revolution of the machine.

The fly may be applied to several sorts of engines, whether moved by men, horses, wind, or water, or any other animate or inanimate power; and is of great use in those parts of an engine which have a quick circular motion, and where the power of the resistance acts unequally in the different parts of a revolution. This has made some people imagine, that the fly adds a new power; but though it may be truly said to facilitate the motion, by making it more uniform, yet upon the whole it causes a loss of power, and not an increase: for as the fly has no motion of its own, it certainly requires a constant force to keep it in motion; not to mention the friction of the pivots of the axis, and the resistance of the air.

The reason, therefore, why the fly becomes useful in many engines, is not that it adds a new force to them; but because, in cases where the power acts unequally, it serves as a moderator to make the motion of revolution almost every where equal: for as the fly has accumulated in itself a great degree of power, which it equally and gradually exerts, and as equally and gradually receives, it makes the motion in all parts of the revolution pretty nearly equal and uniform. The consequence of this is, that the engine becomes more easy and convenient to be acted on and moved by the impelling force; and this is the only benefit obtained by the fly.

The best form for a fly, is that of a heavy



J. Farey Junr del. Lowry sculp.

London, Published by Longman, Hurst Rees & Orme Oct.r 1. 1808.

wheel or circle, of a fit size, as this will not only meet with less resistance from the air, but being continuous, and the weight every where equally distributed through the perimeter of the wheel, the motion will be more easy, uniform, and regular. In this form, the fly is most aptly applied to the perpendicular drill, which it likewise serves to keep upright by its centrifugal force : also to a windlass or common winch, where the motion is quick ; for in pulling upwards from the lower part, a person can exercise more power than in thrusting forward in the upper quarter: where, of course, part of his force would be lost, were it not accumulated and conserved in the equable motion of the fly. Hence, by this means, a man may work all day in drawing up a weight of 40 *lb.* whereas 30 *lb.* would create him more labour in a day without the fly.

In order to calculate the force of the fly, joined to the screw, for stamping the image upon coins, let us suppose the two arms of the fly to be each fifteen inches long, measuring from the centre of the weight to the axis of motion, the weights to be 50 pounds each, and the diameter of the axis pressing upon the dye, to be one inch. If every stroke be made in half a second, and the weights describe an half circumference, which in this case will be four feet, the velocity will at the instant of the stroke be at the rate of eight feet in a second, so that the momentum of it will be 800; but the arms of the fly being as levers, each fifteen inches long, whilst the semi-axis is only half an inch, we must increase this force 30 times, which will give 24,000; an immense force, equal to 100 *lb.* falling 120 feet, or near two seconds in time; or to a body of 750 *lb.* falling $16\frac{1}{12}$ feet, or one second in time. Some engines, for coining crown-pieces, used to have the arms of the fly five times as long, and the weights twice as heavy, so that the effect is ten times greater. See Coining.

Fly, in the sea language, that part of the mariner's compass on which the several winds or points are drawn. "Let fly the sheet," is a word of command to let loose the sheet, in case of a gust of wind, lest the ship should overset, or spend her top-sails and masts; which is prevented by letting the sheet go a-main, that it may hold no wind.

Fly *boat*, a large vessel with a double prow, carrying from four to six hundred tons.

FLYERS, in architecture, such stairs as go straight, and do not wind round; nor have the steps made tapering, but the fore and back part of each stair, and the ends, respectively parallel to one another; so that if one flight do not carry you to your intended height, there is a broad half space, from whence you begin to fly again, with steps every where of the same length and breadth, as before.

FLYING, the progressive motion of a bird, or other winged animal, in the liquid air. The parts of birds chiefly concerned in flying, are the wings, by which they are sustained or wafted along. The tail, Messeurs Willoughby, Ray and many others, imagine to be principally employed in steering and turning the body in the air, as a rudder: but Borelli has put it beyond all doubt, that this is the least use of it, which is chiefly to assist the bird in its ascent and descent in the air ; and to obviate the vacillations of the body and wings: for, as to turning to this or that side, it is performed by the wings, and inclinations of the body, and but very little by the help of the tail. The flying of a bird, in effect, is quite a different thing from the rowing of a vessel. Birds do not vibrate their wings towards the tail, as oars are struck towards the stern, but waft them downwards: nor does the tail of the bird cut the air at right angles, as the rudder does the water; but is disposed horizontally, and preserves the same situation what way soever the bird turns.

In effect, as a vessel is turned about on its centre of gravity to the right, by a brisk application of the oars to the left, so a bird in beating the air with its right wing alone, towards the tail, will turn its fore part to the left. Thus pigeons, changing their course to the left, would labour it with their right wing, keeping the other almost at rest. Birds of a long neck alter their course by the inclinations of their head and neck, which altering the course of gravity, the bird will proceed in a new direction.

The manner of flying is thus: the bird first bends his legs, and springs with a violent leap from the ground; then opens and expands the joints of his wings, so as to make a right line perpendicular to the sides of his body: thus the wings, with all the feathers therein, constitute one continued lamina. Being now raised a little above the horizon, and vibrating the wings with great force and velocity perpendicularly against the subject air, that fluid resists those successions, both from its natural in-

activity and elasticity, by means of which the whole body of the bird, is protruded. The resistance the air makes to the withdrawing of the wings, and consequently the progress of the bird, will be so much the greater, as the waft or stroke of the fan of the wing is longer: but as the force of the wing is continually diminished by this resistance, when the two forces come to be in equilibrio, the bird will remain suspended in the same place; for the bird only ascends so long as the arch of air the wing describes, makes a resistance equal to the excess of the specific gravity of the bird above the air. If the air, therefore, be so rare as to give way with the same velocity as it is struck withal, there will be no resistance and consequently the bird can never mount. Birds never fly upwards in a perpendicular line, but always in a parabola. In a direct ascent, the natural and artificial tendency would oppose and destroy each other, so that the progress would be very slow. In a direct descent they would aid one another, so that the fall would be too precipitate.

Fying, *artificial*, that attempted by men, by the assistance of mechanics. The art of flying has been attempted by several persons in all ages. The Leucadians, out of superstition, are reported to have had a custom of precipitating a man from a high cliff into the sea, first fixing feathers, variously expanded, round his body, in order to break his fall. Friar Bacon, who lived near five hundred years ago, not only affirms the art of flying possible, but assures us, that he himself knew how to make an engine wherein a man sitting might be able to convey himself through the air, like a bird; and further adds, that there was then one who had tried it with success: but this method, which consisted of a couple of large, thin, hollow copper globes, exhausted of the air, and sustaining a person who sat thereon, Dr. Hook shews to be impracticable. The philosophers of K. Charles the second's reign, were mightily busied about this art. Bishop Wilkins was so confident of success in it, that he says, he does not question but, in future ages, it will be as usual to hear a man call for his wings, when he is going a journey, as it is now to call for his boots.

The art of flying has in some measure been brought to bear in the construction and use of balloons. See Ærostation.

Flying *army*, a small body under a lieutenant or major general, sent to harass the country, intercept convoys, prevent the enemy's incursions, cover its own garrisons, and keep the enemy in continual alarm.

Flying *bridge*. See Bridge.

Flying *fish*, a name given by the English writers to several species of fish, which, by means of their long fins, have a method of keeping themselves out of water some time. See Exocoetus, &c.

FOCUS, in geometry and conic sections, is applied to certain points in the parabola, ellipsis, and hyperbola, where the rays reflected from all parts of these curves concur and meet.

Foci *of an ellipsis*, are two points in the longest axis, on which as centres the figure is described. See Ellipsis.

If from the foci two right lines are drawn, meeting one another in the periphery of the ellipsis, their sum will be always equal to the longest axis; and therefore when an ellipsis and its two axis are given, and the foci are required, you need only take half the longest axis in your compasses, and setting one foot in the end of the shorter, the other foot will cut the longer in the focus required.

Focus *of an hyperbola*, is that point in the axis, through which the latus rectum passes; from whence if any two right lines are drawn, meeting in either of the opposite hyperbolas, their difference will be equal to the principal axis. See Hyperbola.

Focus *of a parabola*, a point in the axis within the figure, distant from the vertex one fourth part of the latus rectum. See Parabola.

Focus, in optics, is the point wherein rays are collected, after they have undergone reflection or refraction. See Optics.

FODDER, any kind of meat for horses, or other cattle. In some places, hay and straw, mingled together, is peculiarly denominated fodder.

Fodder, in mining, a measure containing twenty-two hundred and an half weight, though in London but twenty hundred weight.

FŒTUS, in anatomy, a term applied to the offspring of the human subject, or of animals, during its residence in the uterus. The term of ovum is applied to the fœtus, with its membranes and placenta taken altogether. We shall consider under this article the anatomy of the membranes which cover the fœtus during its abode in the uterus; of the placenta, which forms the medium of connexion between the systems

of the mother and child; and of the pregnant uterus itself, since the peculiarities distinguishing its structure at this time arise from the residence of the fœtus in its cavity. The following description applies to the uterus and its contents in the ninth month of gestation. The size of the organ differs much in different individuals; and this arises principally from varieties in the quantity of the liquor amnii. In shape it is oviform; the fundus answering to the largest extremity of the egg, and the cervix and os uteri to the small end. It deviates from this regular figure from various accidental causes, as it adapts itself to the neighbouring parts, to the attitude of the body, and to the position of the contained child. Parts of the latter can often be distinguished in the living state. The small, or lower end of the uterus, is placed in the pelvis; this contains the greater part of the child's head, and fills up the cavity so completely as to press the bladder against the pubes, and the rectum against the sacrum. The body and fundus of the uterus, containing all the rest of the child and the placenta, is placed in the front of the abdomen, from the pelvis upwards to the epigastric region, so as to be under and before all the other bowels. It occupies the whole space from one hip-bone to the other.

The round ligaments, Fallopian tubes, and ovaria, necessarily undergo considerable change in their situation: they become closely connected to the uterus, as that body in its enlargement extends between the two layers of the broad ligaments. The ovaria are particularly distinguished after conception by containing a corpus luteum. This is a firm, fleshy portion, distinguished by its yellowish grey colour from the rest of the ovary, and considered as a certain proof that conception has taken place. If there is one child there is only one corpus luteum; if two children, two of these bodies, &c. The thickness of the pregnant uterus is from one to two-thirds of an inch. The arteries and veins of the uterus are wonderfully increased in size in the pregnant state, particularly opposite to the attachment of the placenta. This change seems to arise naturally from the important office which the vessels have to perform at this period; *viz.* the developement and nutrition of the fœtus. Anatomists have disputed concerning the muscularity of the uterus; but Dr. Hunter describes the appearance of the muscular fibres, which are however very faint. The mouth of the uterus is closed, until the time of labour, by a viscid glutinous substance.

The contents of the pregnant uterus are the secundines, liquor amnii, and the fœtus. The former line the uterus, and immediately cover the child; they form the chain of connexion and communication between the bodies of the mother and child, and carry on that wonderful influence upon which the life and health of the child depend. They are divided into navel-string, placenta, and membranes; and, as they are expelled from the uterus after the birth of the child, they are called the after-birth.

The navel-string is a cord about two feet long, made of three vessels twisted together, and fixed at one end to the child's navel, at the other to the placenta. Its vessels are an umbilical vein and two arteries: the latter carry blood from the child to the placenta, and the former brings it back again.

Placenta. This, with the membranes, makes a complete bag, lining the uterus, and containing the child. It is thick, fleshy, and exceedingly vascular. Its figure is round and flat; about an inch thick, and a span in breadth. The outer surface, which adheres to the womb, is rough, tender, and bloody; the inner is smooth, harder, and marked by the ramifications of the vessels proceeding from the umbilical cord, which is attached to this part. Its substance consists of two parts intimately blended; *viz.* an umbilical, or infantine, and an uterine portion. The former is a continuation of the umbilical vessels of the fœtus, the latter an efflorescence of the internal surface of the uterus. The fœtal portion, which is by far the largest part, is a regular ramification of the arteries and veins of the navel-string into smaller and smaller branches. No communication whatever has been discovered between these vessels and those of the uterus; so that the mode in which the fœtus derives its nourishment and growth must be completely hidden from us.

The uterine portion of the placenta covers its convex surface in the form of a thin membrane, and detaches innumerable fine processes into the substance of the part. It seems to be a portion of the decidua. It is connected into one mass with the umbilical portion, and the vessels of the uterus are continued into it, although they have no discoverable communication with the umbilical arteries and veins.

The membranes are three in number; amnion, chorion, and decidua.

The amnion is firm, thin, transparent, and possessing no visible vessels. It immediately includes the liquor amnii and child. The chorion lies outside of the amnion, and adheres to it; it is transparent, very thin and tender, and adheres externally to the decidua.

The decidua is an efflorescence of the internal coat of the uterus, produced after conception, in order to adapt the womb for the ovum, which is to enter it. It is shed after every birth, or miscarriage, with the other membranes; and hence its name. It is thicker, but more delicate and tender than the amnion or chorion. It contains several blood vessels, which are best seen in recently discharged secundines. It adheres closely to the uterus on one side, and to the chorion on the other. The laceration of the vessels, which this membrane receives from the uterus, accounts for the hemorrhage which follows its separation. At the edge of the placenta it divides into two layers, which pass over the two surfaces of that organ, and form its uterine portion.

The liquor amnii is the fluid immediately surrounding the body of the child, and so called from the membrane enclosing it. Its usual quantity is about two pints. It is a clear, transparent fluid.

The child, while in the uterus, is naturally contracted into an oval form, adapted to the figure and circumstances of its habitation. The vertex of the head makes one end of the oval, and the nates the other. One side or edge of the oval is formed by the occiput, the back part of the neck, and the incurvated trunk; the other is made by the forehead and the mass of contracted and conglomerated limbs. The chin is close to the breast, the trunk bended forwards, the knees close to the fore parts of the hypochoridia, the legs drawn to the back parts of the thighs, and the upper extremities contracted into the vacant space betwixt the forehead and knees. The more or less compact form of the child depends on the quantity of liquor amnii; when that is small, the uterus moulds the child into various forms, and often produces deformities of the limbs. The head is placed downwards with respect to the mother, and the nates upwards.

The usual weight of the child at the time of birth is from five to eight pounds: of several thousands weighed at the British Lying-in Hospital, the largest weighed 11*lb.* 2*oz.* the smallest was above 4*lb.*

The head, upper part of the trunk, and upper extremities, are very large when compared with the lower parts of the body. The surface of the skin is covered pretty generally with a crust of a white sebaceous matter.

Peculiarities in the Structure of the Fœtus.

These are on the whole numerous; but we shall briefly enumerate the most important only.

The first which claim our attention are some points respecting the heart and large blood-vessels; which we may suppose absolutely necessary to the life of the child, while it draws nourishment from the mother, and cannot enjoy respiration. As the fœtus in utero cannot breathe, the circulation of its blood through the lungs would be useless: hence that fluid can go from the right to the left side of the heart by means of an opening called the foramen ovale, and placed between the two auricles, and of a communicating canal from the pulmonary artery to the aorta, called ductus arteriosus. The umbilical arteries are continuations of the internal iliacs, taking the blood from the child to the placenta; from which it is brought back by the umbilical vein, and circulated through the liver.

The lungs are small and compact; and as they have not yet received air, they are specifically heavier than water. This is an important point, and is usually referred to in trials for child-murder, in order to determine whether the child was born alive or no. If the lungs sink in water, it is considered a still-born case; and if they float, the probable inference is, that the child has breathed, but it would be a very rash conclusion that it had, therefore, been murdered. Much caution and consideration of concomitant circumstances must be employed in making use of this proof. Putrefaction will disengage air that may make the lungs float.

The thymus gland, in the chest, is very large in the fœtus; it gradually shrinks after birth, until it entirely disappears. Its use is unknown.

The pupil of the eye is shut until the seventh or eighth month, by a thin pellicle called membrana pupillaris. As a general observation, the eye and ear are very perfect at the time of birth, and almost as large as they ever will be. (N.B. This does not apply to the external ear.)

The small intestines have no valvulæ conniventes. The large are filled with a

dark green mucous, and semifluid substance, called meconium. The liver is of an immense size, and fills two-thirds of the belly.

The renal capsules are very large, equal indeed to the kidnies themselves. Their use is unknown.

The testicle is placed originally in the abdomen, near the kidney; but it passes into the scrotum towards the latter periods of gestation. Sometimes it does not descend on one or both sides till after birth, and sometimes not even during life.

Of the Uterus and its Contents in the earlier Months of Pregnancy.

The conception at first is lodged entirely in the fundus uteri; and no part of it extends into the cervix; which, on the contrary, remains contracted and hard, and filled with a tough and firm jelly. The neck, however, is gradually distended, so that at last there is no distinction between it and the fundus.

The corpus luteum is larger and more vascular, and contains a cavity filled with fluid.

There is a small membranous bag placed on the outer surface of the amnion, and connected to the navel-string, called the vesicula umbilicalis.

The chorion is at first covered all over with fine shaggy and floating processes, which are continuations of the umbilical vessels. By these it adheres to the decidua, and derives its nourishment and supply. These processes are the fœtal portion of the placenta at that time. As the ovum increases they disappear from the general surface of the chorion; become confined to one part, and form the fleshy mass of the placenta.

The decidua is most manifest in the early state of conception, and is thickest at that time. It adheres to the uterus by numerous fine flocculent processes. It is formed by the uterus previously to the entrance of the ovum into its cavity; and is even formed in cases of extra uterine fœtus, where the ovum never enters the uterus.

The placenta does not exist in a very young ovum. The whole outer surface of the chorion is covered with shaggy vessels. In the course of a few weeks one half of the membrane becomes smooth, the remainder being covered as before. These vessels, at their floating extremities, are covered with decidua; and these parts, which at first are separable, gradually become intimately connected, and form a firm mass adhering to the uterus, which is the placenta.

The navel-string is not visible till towards the sixth or seventh week.

The fœtus is discernable about the fourth week after conception. In a particular instance, a very small fœtus was discernible where, from peculiar circumstances, the conception was clearly ascertained to be twenty-two days old.

At this period it consists of two oval masses, the head and trunk; of which the former is bent forwards upon the chest; the eyes are very conspicuous, and form large black prominences; the mouth and tongue are discernible; the body forms a larger and longer oval than the head, with the lower part of the spine curved towards the belly: the upper extremities sprout out from each side of the chest; and the lower from the lower part of the trunk, being considerably smaller than the upper.

FOG, or Mist, a meteor consisting of gross vapours, floating near the surface of the earth. See Meteorology.

FOIL, among glass-grinders, a sheet of tin, with quicksilver or the like, laid on the backside of a looking-glass, to make it reflect.

Foil, among jewellers, a thin leaf of metal placed under a precious stone, in order to make it look transparent, and give it an agreeable different colour, either deep or pale. Thus, if you want a stone to be of a pale colour, put a foil of that colour under it; or if you would have it deep, lay a dark one under it.

FOLIATE, in the higher geometry, a name given by M. de Moivre to a curve of the second order, expressed by the equation $x^3 + y^3 = axy$; being a species of defective hyperbolas with one asymptote, and consisting of two infinite legs crossing one another, and forming a sort of leaf.

FOLIATING *of looking-glasses*, the spreading the plates over, after they are polished with quicksilver, &c. in order to reflect the image. It is performed thus: a thin blotting paper is spread on the table, and sprinkled with fine chalk; and then a fine lamina or leaf of tin, called foil, is laid over the paper; upon this mercury is poured, which is to be distributed equally over the leaf with a hare's foot, or cotton: over this is laid a clean paper, and over that the glass-plate, which is pressed down with the right hand, and the paper drawn gently out with the left: this being done, the plate is covered with a thicker paper, and loaden

with a greater weight, that the superfluous mercury may be driven out, and the tin adhere more closely to the glass. When it is dried, the weight is removed, and the looking-glass is complete. Foliating of globe looking-glasses is done as follows: take five ounces of quicksilver, and one ounce of bismuth; of lead and tin half an ounce each. First put the lead and tin into fusion, then put in the bismuth, and when you perceive that in fusion too, let it stand till it is almost cold, and pour the quicksilver into it: after this, take the glass globe, which must be very clean, and the inside free from dust; make a paper funnel, which put into the hole of the globe, as near to the glass as you can, so that the amalgam, when you pour it in, may not splash, and cause the glass to be full of spots; pour it in gently, and move it about, so that the amalgam may touch every where. If you find the amalgam begin to be curdly and fixed, then hold it over a gentle fire, and it will easily flow again. And if you find the amalgam too thin, add a little more lead, tin, and bismuth to it. The finer and clearer your globe is, the better will the looking-glass be.

FOLIO, in merchants' books, denotes a page, or rather both the right and left hand pages, these being expressed by the same figure, and corresponding to each other.

Folio, among printers and booksellers, the largest form of books, when each sheet is so printed, that it may be bound up in two leaves only. This form is only used in large works; but the quarto or octavo forms are much more handy.

FOLKMOTE, or Folcmote, according to Kennet, was the common-council of all the inhabitants of a city, town, or borough: though Spelman will have the folkmote to have been a sort of annual parliament or convention of the bishops, thanes, aldermen, and freemen on every May-day. Dr. Brady, on the contrary, tells us, that it was an inferior court, held before the King's reeve, or his steward, every month, to do folk right.

FOMAHAUT, in astronomy, a star of the first magnitude in the constellation Aquarius.

FOMENTATION, in medicine, the bathing any part of the body with a convenient liquor; which is usually a decoction of herbs, water, wine, or milk; and the applying of bags stuffed with herbs and other ingredients, which is commonly called dry fomentation. Fomentations differ in little else from embrocations, but that they are mostly made with aqueous menstruums, are more extensive in their manner of application, and are assisted by actual heat, and hot woollen cloths: add to this, that fomentations, when general, or applied to every part of the body, are called baths.

FONT, among ecclesiastical writers, a large bason, in which water is kept for the baptizing of infants, or other persons. It is so called, probably, because baptism was usually performed among the primitive christians at springs or fountains. In process of time the font came to be used, being placed at the lower end of the church, to intimate, perhaps, that baptism is the rite of admission into the Christian church.

Font. See Fount.

FONTANESIA, in botany, so named in honour of Mons. Desfontaines, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: calyx four-parted, inferior; petals two, two-parted; capsule membranaceous, not opening, two-celled; cells one-seeded. There is but one species.

FONTINALIS, in botany, a genus of the Cryptogamia Musci, or Mosses. Generic character: capsule oblong, with the mouth ciliate; opening with an acuminate lid; covered with a sessile, smooth, conical veil; included in a pitcher-shaped, imbricate perichætium. Only four species are known, and they are all natives of England: three of them are water mosses, and one grows upon trees. Professor Martyn says, that several new species have been discovered by Swartz in the West Indies.

FOOD, implies whatever aliments are taken into the body to nourish it. See Dietetics.

FOOL, according to Mr. Locke, is a person who makes false conclusions from right principles; whereas a madman, on the contrary, draws right conclusions from wrong principles.

FOOT, *pes*, a part of the body of most animals, whereon they stand, walk, &c.

Animals are distinguished, with respect to the number of their feet, into bipedes, two-footed; such are men and birds: quadrupedes, four-footed; such are most land-animals: and multipedes, or many-footed; as insects. The reptile-kind, as serpents, &c. have no feet; the crab-kind of fish have got ten feet, but most other fishes have no feet at all; the spider, mites, and polypuses

have eight; flies, grass-hoppers, and butterflies have six feet; animals destined to swim, and water-fowl, have their toes webbed together, as the phocæ, goose, duck, &c.; the fore-feet of the mole, rabbit, &c. are wonderfully formed for digging and scratching up the earth, in order to make way for their head.

FOOT. See ANATOMY.

FOOT, in the Latin and Greek poetry, a metre or measure, composed of a certain number of long and short syllables. These feet are commonly reckoned twenty-eight, of which some are simple, as consisting of two or three syllables, and therefore called disyllabic or trisyllabic feet; others are compound, consisting of four syllables, and are therefore called tetrasyllabic feet.

FOOT is also a long measure, consisting of twelve inches. Geometricians divide the foot into ten digits, and the digit into ten lines. See DIGIT and LINE.

FOOT *square*, is the same measure both in breadth and length, containing 144 square or superficial inches.

FOOT *cubic*, or *solid*, is the same measure in all the three dimensions, length, breadth, and depth or thickness, containing 1728 cubic inches. The foot is of different lengths in different countries. The Paris royal foot exceeds the English by nine lines; the ancient Roman foot of the Capitol consisted of four palms, equal to $11\frac{7}{10}$ inches English; Rhineland or Leyden foot, by which the northern nations go, is to the Roman foot, as 950 to 1000. See MEASURE.

FOOT *geld*, or *Faut-geld*, in our old customs, an amercement laid upon those who live within the bounds of a forest, for not lawing or cutting out the ball of their dog's feet. To be free of a foot-geld, was a privilege to keep dogs unlawed, within the bounds of a forest.

FOOT *level*, among artificers, an instrument that serves as a foot-rule, a square, and a level. See LEVEL.

FORAGE, in military affairs, implies hay, straw, and oats, for the subsistence of the army horses. It is divided into rations, of which one is a day's allowance for a horse, and contains 20*lb.* of hay, 10*lb.* of oats, and 5*lb.* of straw. When cavalry is stationed in barracks in Great Britain, the number of rations of forage is, to field-officers four, supposing them to have four effective horses; to captains three; to staff-officers two; to quarter-masters, non-commissioned officers, and privates, each one. On foreign service, this article is governed by circumstances.

FORAMEN, in anatomy, a name given to several apertures, or perforations in divers parts of the body; as, the foramen lachrymale, &c. See ANATOMY.

FORCE, in mechanics, denotes the cause of the change in the state of a body when being at rest it begins to move, or has a motion which is either not uniform, or not direct. Mechanical forces may be reduced to two sorts, one of a body at rest, the other of a body in motion. See MECHANICS. The force of a body at rest is that which we conceive to be in a body lying still on a table, or hanging by a rope, or supported by a spring, and is called by the names of pressure, *vis mortua*, &c. The measure of this force being the weight with which the table is pressed, or the spring bent.

The force of a body in motion, called moving force, *vis motrix*, and *vis viva*, to distinguish it from the *vis mortua*, is allowed to be a power residing in that body so long as it continues its motion, by means of which it is able to remove obstacles lying in its way, to surmount any resistance, as tension, gravity, friction, &c. and which, in whole or in part, continues to accompany it so long as the body moves.

We have several curious, as well as useful observations, in Desagulier's "Experimental Philosophy," concerning the comparative forces of men and horses, and the best way of applying them. A horse draws with the greatest advantage when the line of direction is level with his breast; in such a situation, he is able to draw 200*lb.* eight hours a-day, walking about two miles and a half an hour. And if the same horse is made to draw 240*lb.* he can work but six hours a-day, and cannot go quite so fast. On a carriage indeed, where friction alone is to be overcome, a middling horse will draw 1000*lb.* But the best way to try a horse's force, is by making him draw up out of a well, over a single pulley or roller; and, in such a case, one horse with another will draw 200*lb.*, as already observed. Five men are found to be equal in strength to one horse, and can, with as much ease, push round the horizontal beam of a mill, in a walk forty feet wide; whereas three men will do it in a walk only nineteen feet wide. The worst way of applying the force of a horse, is to make him carry or draw up hill; for if the hill be steep, three men will do more than a horse, each man climbing

up faster with a burden of 100*lb.* weight, than a horse that is loaded with 300*lb.*; a difference which is owing to the position of the parts of the human body being better adapted to climb than those of a horse. On the other hand, the best way of applying the force of a horse, is in a horizontal direction, wherein a man can exert least force; thus a man weighing 140*lb.*, and drawing a boat along by means of a rope coming over his shoulders, cannot draw above 27*lb.*, or exert above one-seventh part of the force of a horse employed to the same purpose. The very best and most effectual posture in a man, is that of rowing, in which he not only acts with more muscles at once, for overcoming the resistance, than in any other position; but, as he pulls backward, the weight of his body assists by way of lever.

FORCE *accelerative*, or *Retardive Force*, is that which respects the velocity of the motion only, accelerating or retarding it; and it is denoted by the quotient of the motive force, divided by the mass or weight of the body. So, if m denote the motive force, and b the body, or its weight, and f the accelerating or retarding force, then is f as $\frac{m}{b}$. Again, forces are either constant or variable. Constant forces are such as remain and act continually the same for some determinate time. Such, for example, is the force of gravity, which acts constantly the same upon a body, while it continues at the same distance from the centre of the earth, or from the centre of force, wherever that may be. In the case of a constant force F, acting upon a body b, for any time t, we have these following theorems; putting $f =$ the constant accelerating force $= F \div b$; $v =$ the velocity at the end of the time t; $s =$ the space passed over in that time, by the constant action of that force on the body: and $g = 16\frac{1}{12}$ feet, the space generated by gravity in 1 second, and calling the accelerating force of gravity 1; then is

$$s = \tfrac{1}{2} tv = gft^2 = \frac{v^2}{4gf}; \quad v = 2gft = \frac{2s}{t} = \sqrt{4gfs}; \quad t = \frac{v}{2gf} = \frac{2s}{v} = \sqrt{\frac{s}{gf}}; \quad f = \frac{v}{2gt} = \frac{s}{gt^2} = \frac{v^2}{4gs}.$$

FORCES *variable*, are such as are continually changing in their effect and intensity; such as the force of gravity at different distances from the centre of the earth, which decreases in proportion as the square of the distance increases. In variable forces, theorems similar to those above may be exhibited, by using the fluxions of quantities, and afterwards taking the fluents of the given fluxional equations. And herein consists one of the great excellencies of the Newtonian or modern analysis, by which we are enabled to manage and compute the effects of all kinds of variable forces, whether accelerating or retarding. Thus, using the same notation as above for constant forces, *viz.* f, the accelerating force at any instant; t, the time a body has been in motion by the action of the variable force; v, the velocity generated in that time; s, the space run over in that time; and $g = 16\frac{1}{12}$ feet; then is

$$\dot{s} = \frac{v\dot{v}}{2gf} = v\dot{t}; \quad \dot{v} = \frac{2gf\dot{s}}{v} = 2gf\dot{t}; \quad \dot{t} = \frac{\dot{s}}{v} = \frac{\dot{v}}{2gf}; \quad f = \frac{v\dot{v}}{2g\dot{s}} = \frac{\dot{v}}{2g\dot{t}}.$$

In these four theorems, the force f, though variable, is supposed to be constant for the indefinitely small time $\dot{t}$; and they are to be used in all cases of variable forces, as the former ones in constant forces; *viz.* from the circumstances of the problem under consideration, deduce a general expression for the value of the force f, at any indefinite time t; then substitute it in one of these theorems, which shall be proper to the case in hand; and the equation thence resulting will determine the corresponding values of the other quantities in the problem. It is also to be observed, that the foregoing theorems equally hold good for the destruction of motion and velocity, by means of retarding or resisting forces, as for the generation of the same by means of accelerating forces.

FORCEPS, a pair of nippers, or pinchers, for laying hold of and pulling out any thing forced into another body.

FORCEPS, in surgery, &c. a pair of scissars for cutting off, or dividing, the fleshy or membraneous parts of the body, as occasion requires.

Forceps are commonly made of steel, but those of silver are much neater.

FORCER, or *forcing pump*, in mechanics, is a kind of pump in which there is a forcer or piston without a valve. See PUMP.

FORCIBLE entry and *detainer*. Forcible entry, is a violent actual entry into a house or land, &c., or taking a distress of any person, armed, whether he offer violence or fear of hurt to any there, or furiously drive any out of the possession; if one enter another's house, without his consent, al-

though the doors be open, this is a forcible entry punishable by the law.

And an indictment will lie at common law for a forcible entry, though generally brought on the several statutes against forcibly entry. The punishment for this offence is by fine and imprisonment.

Forcible *marriage*, if any person shall take away any woman having lands or goods, or that is heir apparent to her ancestors, by force and against her will, and afterwards she be married to him, or to another by his procurement; or defiled; he, and also the procurers, and receivers of such a woman, shall be adjudged principal felons. And by 39 Eliz. c. 9, the benefit of clergy is taken away from the principals, procurers, and accessaries before. And by 4 and 5 Phil. and Mary c. 8, if any person shall take or convey away any unmarried woman, under the age of sixteen (though not attended with force), he shall be imprisoned two years, or fined, at the discretion of the court; and if he deflower her, or contract matrimony with her without the consent of her parent or guardian, he shall be imprisoned five years, or fined in like manner. And the marriage of any person under the age of twenty-one, by licence, without such consent, is void.

FORCING, among gardeners, signifies the making trees produce ripe fruit before their usual time. This is done by planting them in a hot-bed against a south-wall, and likewise defending them from the injuries of the weather by a glass frame. They should always be grown trees, as young ones are apt to be destroyed by this management. The glasses must be taken off at proper seasons, to admit the benefit of fresh air, and especially of gentle showers.

FORECASTLE, in naval affairs, a short deck placed in the fore-part of the ship above the upper deck, it is usually terminated both before and behind in vessels of war by a breast work, the foremost part forming the top of the beak-head, and the hind part reaching to the after part of the fore chains. Forecastle men, are sailors stationed there, and are of the best kind as to experience and discipline.

Fore *foot*, in ship-building, a piece of timber which terminates the keel at the fore-end; it is connected by a scarf to the extremity of the keel, and the other end of it which is incurvated upwards into a sort of knee, is attached to the lower end of the stem; it is also called a gripe.

Fore *foot*, in the sea-language, signifies one ship's lying, or sailing, across another's way: as if two ship's being under sail, and in ken one of another, one of them lying in her course with her stem so much a weather the other, that holding on their several ways, neither of them altering their courses, the windward ship will run a head of the other: then it is said, such a ship lies with other's fore foot.

Foreign *seamen* serving two years on board British ships, whether of war, trade, or privateers, during the time of war, shall be deemed natural born subjects.

FORELORN *hope*, in the military art, signifies men detached from several regiments, or otherwise appointed, to make the first attack in day of battle, or, at a siege, to storm the counterscarp, mount the breach, or the like. They are so called from the great danger they are unavoidably exposed to; but the word is old, and begins to be obsolete.

FOREMAST *of a ship*, a large, round piece of timber, placed in her fore-part, or forecastle, and carrying the fore-sail and fore-top-sail yards. Its length is usually $\frac{8}{9}$ of the main-mast. And the fore-top-gallant-mast is $\frac{1}{2}$ the length of the fore-top-mast. See Mast.

Foremast *men* are those on board a ship that take in the top sails, fling the yards, furl the sails, bowse, trice, and take their turn at the helm, &c.

FORE *reach*, in the sea language, a ship is said to fore reach upon another, when both sailing together, one sails better, or outgoeth the other.

FORESCHOKE, in our old authors, signifies the same with forsaken, and is particularly used in one of our statutes for lands or tenements seised by the lord for want of services performed by his tenant, and quietly held by such lord above a year and a day, without any due course of law taken by the tenant for recovery thereof; here he does in presumption of law disavow or forsake all the rights he has thereto, for which reason those lands shall be called foreschoke.

FORESKIN, in anatomy, the same with prepuce. See Prepuce.

FORE *staff*, or cross-staff, an instrument used at sea for taking the altitude of the sun, moon, or stars. It is called fore-staff, because the observer, in using it, turns his face towards the object; whereas in using

Davis's quadrant, the back of the observer is towards the object; and hence its denomination of back-staff.

FORESTALLING, is the buying or bargaining for any corn, cattle, or other merchandize, by the way, before it comes to any market or fair, to be sold; or by the way, as it comes from beyond the seas, or otherwise, towards any city, port, haven, or creek of this realm, to the intent to sell the same again at a higher price.

At the common law, all endeavours to enhance the common price of any merchandize, and all practices which have an apparent tendency thereto, whether by spreading false rumours, or by purchasing things in a market before the accustomed hour, or by buying and selling again the same thing in the same market, or by any other such like devices, are highly criminal, and punishable by fine and imprisonment.

Several statutes have, from time to time, been made against these offences in general, which were repealed by 12 Geo. III. c. 71.

But though these offences are still punishable upon indictment at the common law, by fine and imprisonment, the propriety of laws against forestalling has been lately very much doubted by some of the most eminent writers upon political economy, and they are now seldom enforced.

FORESTER, a sworn officer of the forest, appointed by the king's letters patent, to walk the forest at all hours, watch over the vert and venison; also to make attachments and true presentments of all trespasses committed within the forest.

Forests, are waste grounds belonging to the king, replenished with all manner of beasts of chase on venery, which are under the king's protection, for the sake of his royal recreation; and there are particular laws, privileges, courts and officers belonging to the king's forests. The forest courts are, the courts of attachments, of regard, of swainmote, and of justice seat, &c. But as the forest laws have long ago ceased to be put in execution, we shall not enumerate them.

FORFEITURE, is a punishment annexed by law, to some illegal act or negligence in the owner of lands, tenements, or hereditaments, whereby he loses all his interest therein, and they go to the party injured, as a recompence for the wrong which either he alone, or the public together with him have sustained. The offences which induce a forfeiture of lands and tenements, are principally the following: treason, felony, misprision of treason, premunire, drawing a weapon on a judge; or striking any one in the presence of the king's court of justice. By the common law; all lands of inheritance whereof the offender is seised in his own right, and also all rights of entry to lands, in the hands of a wrong doer, are forfeited to the king on an attainder of high treason, although the lands are holden of another. Also upon an attainder of petit treason or felony, all lands of inheritance, whereof the offender is seised in his own right, as also rights of entry to lands in the hands of a wrong doer, are forfeited to the lord of whom they are immediately holden; for this by the feudal law, was deemed a breach of the tenants' oath of fealty in the highest manner; his body with which he had engaged to serve the lord, being forfeited to the king, and thereby his blood corrupted, so that no person could represent him; and all personal states, whether they are in action or possession, which the party has, or is entitled to, in his own right, and not as executor or administrator to another, are liable to such forfeiture in the following cases:

1st. Upon a conviction of treason or felony. 2d. Upon a flight found before the coroner, on view of a dead body. 3d. Upon an acquittal on a capital felony, if the party be found to have fled. 4th. If any person indicted of petit larceny and acquitted, be found to have fled for it, he forfeits his goods as in cases of grand larceny. 5th. Upon a presentment by the oaths of 12 men, that a person arrested for treason or felony, fled from, or resisted those who had him in custody, and was killed by them in the pursuit or scuffle. 6th. If a felon waive, that is, leave any goods in his flight from those who either pursue him, or are apprehended by him so to do, he forfeits them, whether they are his own goods, or goods stolen by him; and at common law, if the owner did not pursue and appeal the felon, he lost the goods for ever: but by 21 Hen. VIII. c. 11. for encouraging the prosecution of felons, it is provided, that if the party came in as evidence on the indictment, and attaint the felon, he shall have a writ of restitution. 7th. If a man be felo de se, he forfeits his goods and chattels. 8th. A convict, within clergy, forfeits all his goods, though he be burnt in

the hand; yet thereby he becomes capable of purchasing other goods. But, on burning in the hand, he ought to be immediately restored to the possession of his lands. The forfeiture upon an attainder of treason or felony shall have relation to the time of the offence, for the avoiding all subsequent alienation of the lands; but to the time of conviction, on *fugam fecit* found, &c. only, as to chattels, unless the party were killed in flying from, or resisting those who had arrested him: in which case, it is said that the forfeiture shall relate to the time of the offence.

FORFICULA, in natural history, the *earwig*, a genus of insects of the order Coleoptera. Antennæ setaceous; feelers unequal, filiform; shells half as long as the abdomen; wings folded up under the shells; tail armed with a forceps. There are eighteen species enumerated by Gmelin, two of which are natives of this country, *viz.* F. auricularia and F. minor. The former is too well known to stand in need of any particular description: it flies only by night, and can scarcely be made to expand its wings by day. The female deposits her eggs, which are rather large, white, and oval, under stones, in any damp situation, where they may be secure from too great heat or drought. From the eggs are hatched the larvæ, which are small, but possessing the general aspect of the parent animal, except being of a white colour. The parent insect, it is said, broods over her young, as the hen over her chickens. They change their skin at certain intervals during the earlier stages of their growth, and thus gradually acquire a darker colour, till at length the wing-sheaths and wings are formed, and the animals may be considered as perfect. The usual food of the earwig consists of decayed fruit: it will, however, if kept without food, attack and devour its own species. Gmelin seems to agree with the vulgar notion of its creeping into the ears of such as sleep in the open air; but Dr. Shaw regards it as an ancient, though generally received error. Others have, however, taken for granted, that such accidents may happen; and observe, that when this or any other insect falls into the ear, a little oil poured in will immediately kill it, after which it may be picked out, or discharged with a syringe of warm water.

FORGE, properly signifies a little furnace, wherein smiths and other artificers of iron or steel, &c. heat their metals red hot, in order to soften and render them more malleable and manageable on the anvil. An ordinary forge is nothing but a pair of bellows, the nozzle of which is directed upon a smooth area, on which coals are placed. The nozzle may also be directed to the bottom of any furnace, to excite the combustion of the coals placed there, by which a kind of forge is formed. In laboratories there is generally a small furnace consisting of a cylindrical piece, open at top, which has at its lower side a hole for receiving the nozzle of a double bellows. This kind of forge furnace is very convenient for fusions, as the operation is quickly performed, and with few coals. In its lower part, a little above the hole for receiving the nozzle of the bellows, may be placed an iron plate of the same diameter, supported upon two horizontal bars, and pierced near its circumference with four holes diametrically opposite to each other. By this disposition the wind of the bellows, pushed forcibly under this plate, enters at these holes; and thus the heat of the fire is equally distributed, and the crucible in the furnace is equally surrounded by it. As the wind of bellows strongly and rapidly excites the action of the fire, a forge is very convenient when a great heat is required. The forge, or blast-bellows, is used to fuse salts, metals, ores, &c. It is much used also in works which require strong heat, without much management; and chiefly in the smelting of ores, and fusion of metallic matters.

Forge, in the train of artillery, is generally called a travelling forge, and may not be improperly called a portable smith's shop: at this forge all manner of smith's work is made, and it can be used upon a march, as well as in camp.

Forge is also used for a large furnace, wherein iron-ore, taken out of the mine, is melted down; or it is more properly applied to another kind of furnace, wherein the iron-ore, melted down and separated in a former furnace, and then cast into sows and pigs, is heated and fused over again, and beaten afterwards with large hammers, and thus rendered more soft, pure, ductile, and fit for use.

FORGERY, is where a person counterfeits the signature of another, with intent to defraud; which by the law of England is made a capital felony. This law is now extended by statute to the counterfeiting of almost every written instrument which is either a security for money or a public do-

cument or voucher upon which money may be received, or by which any one may be defrauded of money by the act of imposing upon him such a false instrument. To enumerate the several statutes upon the subject, would here be impossible. It is generally punished with the most rigorous severity. We shall add a few detached points with respect to the cases of forgery, which may be useful to explain cases of frequent occurrence.

Forgery may be committed by making a mark in the name of another person. It may be also committed in the name of a person who never had existence. Thus, indorsing a real bill of exchange, with a fictitious name, is forgery, although the use of a fictitious name was not essential to the negociation.

A receipt indorsed on a bill of exchange, in a fictitious name, is forgery, although such name does not purport to be the name of any particular person. If a person, who has for many years been known by a name which was not his own, and afterwards assume his real name, and in that name draw a bill of exchange, he will not be guilty of forgery, although such bill were drawn for fraudulent purposes.

The following statute is one of the most generally applicable to cases of forgery. If any person shall falsely make, forge, or counterfeit, or cause or procure to be falsely made, forged, or counterfeited, or willingly aid or assist in the false making or counterfeiting any deed, will, bond, writing, obligatory, bill of exchange, promissory note for payment of money, acquittance, or receipt, either for money or goods, with intent to defraud any person, or shall utter or publish the same as true, knowing the same to be false, forged, or counterfeited, he shall be guilty of felony without benefit of clergy; but not to work corruption of blood, or disherison of heirs. 2 Geo. II. c. 25. From this, as well as other statutes, it will be seen that not only the counterfeiting or forging false instruments, but the uttering, passing, or putting them off knowingly, is a capital felony; and in order to detect counterfeiters or forgers of bank notes, the being possessed only of such forged notes, knowing them to be forged, is now made by a late statute a transportable offence.

FORGING, in smithery, the beating or hammering iron on the anvil, after having first made it red hot in the forge, in order to extend it into various forms, and fashion it into works. See FORGE.

FORGING, or imitating stamps to defraud the revenue, is a capital forgery by the several stamp acts; and the receiving them knowingly is made single felony, punishable with seven years transportation. 12 Geo. III. c. 48. A person was lately executed for forging the ace of spades to a pack of cards.

FORM denotes the external appearance or surface of a body, or the disposition of its parts, as to the length, breadth, and thickness.

FORM, among mechanics, for a sort of mould, whereon any thing is fashioned or wrought: as the hatters' form, the papermakers' form, &c.

FORM, *printers'*, an assemblage of letters, words, and lines, ranged in order, and so disposed into pages by the compositor; from which, by means of ink and a press, the printed sheets are drawn. Every form is inclosed in an iron chase, wherein it is firmly locked by a number of pieces of wood; some long and narrow, and others of the form of wedges. There are two forms required for every sheet, one for each side; and each form consists of more or fewer pages, according to the size of the book.

FORM *of a series*, in algebra, that affection of an undeterminate series, which arises from the different values of the indices of the known quantity. See SERIES.

FORMA *pauperis*, in law, is when any person has cause of suit, and is so poor that he cannot support the usual charges of suing at law or in equity. Upon his making oath that he is not worth five pounds, his debts being paid, and bringing a certificate from some barrister, that he has just cause of suit, the judge admits him to sue in *forma pauperis*, that is, without paying fees to counsellor, attornies, or clerk; and he shall have original writs and subpœnas gratis. And he shall, when plaintiff, be excused from costs, but shall suffer other punishment at the discretion of the judge. And it was formerly usual to give such paupers, if nonsuited, their election either to be whipped, or pay the costs; though the practice is now disused.

It seems agreed, that a pauper may recover costs, though he pay none; for although the counsel and clerks are bound to give their labour to him, yet they are not bound to give it to his opponent.

FORMEDON, a real action to recover the right by the tenant in tail, or the reversioner, and which is called formedon because

the title or form of the done or gift is stated in the writ; there are three sorts, in the descender, remainder, and revertor. But these writs are now seldom brought, except in some special cases, where it cannot be avoided; the trial of titles by ejectment is now the usual method, and is done with much less trouble and expense.

FORMIC *acid*. It has long been known that ants contain a strong acid, which they occasionally emit; and which may be obtained from the ants either by simple distillation or by infusion of them in boiling water and subsequent distillation of as much of the water as can be brought over without burning the residue. After this it may be purified by repeated rectifications, or by boiling to separate the impurities; or after rectification it may be concentrated by frost.

This has now lost its rank as a separate acid, and it has been shewn by Fourcroy and Vauquelin to be a compound of the malic and acetic.

We have been informed that it has been employed among quacks as a wonderful remedy for the tooth-ach, by applying it to the tooth with the points of the fore-finger and thumb.

FORMICA, in natural history, the *ant* or *emmet*, a genus of insects of the order Hymenoptera. Feelers four, unequal, with cylindrical articulations, placed at the tip of the lip, which is cylindrical and nearly membranaceous; antennæ filiform; a small erect scale between the thorax and abdomen; females and neuters armed with a concealed sting; males and females with wings, but to neuters there are no wings. This is a gregarious and very industrious family, consisting, as the generic character shews, of males, females, and neutrals. The last are well-known insects, who construct the nests or ant-hills, who labour with unremitting assiduity for the support of themselves and the males and females, and who guard with such ferocity the larvæ, or what are usually denominated ant's eggs. They wander about all day in search of food or materials for the nest, and assist each other in bringing home what is too heavy or large for such as have attempted it. They bring out of their nest, to expose to the warmth of the sun, the newly hatched larvæ, and feed them till they are able to provide for themselves. In the evening they consume together whatever has been collected during the day, and do not, as is commonly supposed, lay up any store for the winter. They are very covetous of aphides, (see APHIS) and are themselves eagerly sought after by the formica-leo, and various birds. Ants feed on animal and vegetable substances, devouring the smaller kind of insects, caterpillars, &c. as well as fruits of different kinds. The largest of the European ants is the F. herculanea, or great wood-ant, of a chesnut colour, which is found in dry woods of fir, where it inhabits a large nest or hillock, composed of dry vegetable fragments, chiefly of fir-leaves: the nest is internally distributed into several paths or tubes, converged towards a central part, and opening externally; in the centre reside the larvæ, which are nursed by neutral ants. When full grown, they envelope themselves in oval white silken cases, in which they undergo their change into the chrysalis state, and at length emerge in their complete form.

F. nigra is the common black ant, well known in our gardens and fields. The great desire that ants have for animal food has been made use of by anatomists, who, when they wish to obtain the skeleton of an animal too small or delicate to admit of being prepared in the usual way, dispose the animals in a proper position in a small box, with perforations in the lid, and deposit it in a large ant-hill, in consequence of which, after a certain time, the whole of the softer parts are eaten away by these insects, and the skeleton remains in its proper position.

F. rufa contains an acid which has undergone a chemical analysis, &c. See FORMIC *acid*.

FORMULA, or FORMULARY, a rule or model, or certain terms prescribed or decreed by authority, for the form and manner of an act, instrument, proceeding, or the like.

FORMULA, in church history and theology, signifies a profession of faith.

FORMULA, in medicine, imports the constitution of medicines, either simple or compound, both with respect to their prescription and consistence.

FORMULA, a theorem or general rule or expression for resolving certain particular cases of some problem, &c. So $\frac{s}{2}+\frac{d}{2}$ is a general formula for the greater of two quantities whose sum is s and difference d; and $\frac{s}{2}-\frac{d}{2}$ is the formula, or general value for the less quantity. Again $\sqrt{dx-x^2}$ is the formula or general value of the ordinate

to a circle, whose diameter is d and abscisss x.

FORMULARY, a writing containing the form of an oath, declaration, attestation, abjuration, &c. to be made on certain occasions.

FORNICATION, the act of incontinency in single persons; for if either party be married, it is adultery; the spiritual court hath the proper cognizance of this offence; but formerly the courts'-leet had power to inquire of and punish fornication and adultery; in which courts the King had a fine assessed on the offenders, as appears by the book of domesday.

FORSKOHLEA, in botany, so named in honour of Peter Forskahl, a Swede, a genus of the Octandria Tetragynia class and order. Natural order of Urticæ, Jussieu. Essential character: calyx four or five leaved, longer than the corolla; petals eight or ten, spatulate; pericarpium none; seeds five, connected by wool. There are three species.

FORSTER (JOHN REINHOLD), in biography, an eminent naturalist and philologist, was born on the 22d of October 1729, at Derschaw, in Polish Prussia, where his father was a burgomaster. He received very little education, except what he acquired himself by the natural strength of his own genius, till the year 1743, at which period he was placed for a year at the public school of Marienwerder; and when about fifteen, he was sent to Berlin, where he was admitted into the gymnasium of Joachimsthal. Having a decided attachment to the learned languages, he made great progress under Mezelius and Heinsius; and even while at school, applied to the study of the Coptic. He applied also to several of the modern languages, and particularly the Polish, which he had an opportunity of speaking with his schoolfellows, many of whom were Poles, and among whom, at that time, was a very extraordinary genius, Stanislaus von Siestrzencewitz, who, through ambitious views, afterwards embraced the Catholic religion, and, on account of his eloquence, was raised to the dignity of a bishop. Among his school-fellows also at this time, were Cochius, Resewitz, Irving, and the celebrated Pallas, now professor at Petersburg.

In the year 1748, he was entered at the University of Halle; his inclination led him to the study of medicine; but his father was desirous that he should apply to jurisprudence: he however studied theology, and indulged his taste for the learned languages, among which he included the Oriental.

In the year 1751, he left the University, and repaired to Dantzic, where he soon distinguished himself by his sermons, in which he imitated the French rather than the Dutch manner, at that time the most prevalent. After being two years a candidate, he obtained a settlement, in 1753, at Nassenhuben, and in the month of February next year, married his own cousin, Elizabeth Nikolai. While in this situation, he devoted great part of his leisure hours to philosophy, geography, and the mathematics, which were now his favourite pursuits; and he improved himself still farther in the knowledge of ancient and modern languages; but his income being small, and his family increasing, he had to struggle with difficulties, which induced him to accept an offer made to him by the Russian resident at Dantzic, of going to Russia to superintend the new colonies at Saratow. At Petersburgh he gave so much satisfaction to the members of government, that Count Orlof, who at that time enjoyed unlimited power, wrote to the resident at Dantzic, to thank him for having engaged a man of such great talents, and so agreeable to his wishes. But, whether Forster had shewn himself too warm a friend of the colonists, had expressed his sentiments with too much freedom, or given offence to Orlof in some other manner, he soon returned to Petersburgh without completing his engagement. On his return to the capital, he had advantageous offers made to him by the Academy of Sciences, and by that of Moscow, but he declined both. In the mean time the congregation at Nassenhuben, whom he had left, insisted either on his returning or giving up the place. As he had still hopes that the Russian government would fulfil its promise, and make some provision for him, he preferred the latter; but his patience having been exhausted, his friends at Berlin, who had reason to expect hearing of his being on the Banks of the Wolga, received letters from London, in the month of July 1766, in which he stated that he had left Russia in disgust, and had proceeded to England, with very little money, but with strong recommendations. After his arrival in London, he received from the Russian government a present of a hundred guineas; and by translating Kalm's Travels, and Osbeck's Voyage, he procured some additional funds towards the support of his family. He had an offer from Lord Balti-

more of being superintendant of his extensive property in America, but this he declined, and accepted the place of teacher of the French, German, and natural history, in the academy of Warrington. This place, however, he left soon after, and returned to London, where he resided in very confined circumstances till the year 1772, when he was engaged to go out as naturalist with Captain Cook, who was then ready to proceed on his second voyage round the world. Forster, at this time, was forty-three years of age, and was accompanied by his son George, then seventeen.

He returned to England in the year 1775, and soon after the University of Oxford conferred upon him the degree of Doctor of Laws. After his return, he published, conjointly with his son, a botanical work in Latin, containing the characters of a number of new genera of plants, which had been discovered by them in the course of their circumnavigation.

An account of the voyage having been published in English and German by young Forster, in which the father was supposed to have had a considerable share, though he had entered into an engagement not to publish any thing separately from the authorized narrative, they not only incurred the displeasure of government, but gave offence to the principal friends by whom they had been patronised. This work abounded with reflections injurious to the government in whose service they had been, and unfavourable to the navigators who had conducted the expedition. They were therefore treated with so much coolness that they both determined to quit England.

Fortunately for Forster, after struggling some time with poverty and misfortunes in London, he was invited to Halle, in 1780, to be professor of natural history; he was also appointed inspector of the botanical garden; and as this office was connected with the faculty of medicine, he next year got the degree of Doctor of Medicine.

The loss of his son George, who died at an early period of life, made a deep impression on Forster, whose health was already in a declining state; and in the spring of the year 1798, his case was so desperate, that he expressed himself as a dying man in a letter to his friend Harsten, dated Halle, April 14. He did not long survive this letter, dying on the 9th of December, 1798, at the age of sixty-nine years and some months.

Forster is represented as a man of highly irritable and quarrelsome disposition, of which he is said to have given several instances during his voyage round the world; and which, added to a total want of prudence in common affairs, involved him, notwithstanding his talents, in perpetual difficulties.

The following character of him, by his friend the celebrated Kurt Sprengel, of Halle, exhibits him in a more favourable point of view: "To a knowledge of books, in all branches of science, seldom to be met with, he joined an uncommon fund of practical observations, of which he well knew how to avail himself. In natural history, in geography, both physical and moral, and in universal history, he was acquainted with a vast number of facts, of which he who draws his information from works only, has not even a distant idea. This assertion is proved in the most striking manner by his 'Observations made in a Voyage round the World.' Of this book it may be said, that no traveller ever gathered so rich a treasure on his tour. What person of any education can read and study this work, which is unparalleled in its kind, without discovering in it that species of instructive and pleasing information which most interests man, as such? The uncommon pains which Forster took in his literary compositions, and his conscientious accuracy in historical disquisitions, are best evinced by his 'History of Voyages and Discoveries in the North,' and likewise by his excellent archæological dissertation 'On the Byssus of the Ancients.' Researches such as these were his favourite employment, in which he was greatly assisted by his intimate acquaintance with the classics. Forster had a predilection for the sublime in natural history, and aimed at general views, rather than detail. His favourite author therefore was Buffon, whom he used to recommend as a pattern of style, especially in his 'Epoques de la Nature,' his 'Description of the Horse, Camel, &c.' He had enjoyed the friendship of that distinguished naturalist, and he likewise kept up an uninterrupted epistolary intercourse with Linnæus, till the death of the latter. Without being a stickler for the forms and ceremonies of any particular persuasion, he adored the Eternal Author of All, who exists in the great temple of nature, and venerated his wisdom and goodness with an ardour and a heart-felt conviction that, in his opinion, alone constituted the criterion of true religion. He held in utter

contempt all those who, to gratify their passions, or imitate the prevailing fashion, made a jest of the most sacred and reputable feelings of mankind. His moral feelings were equally animated; he was attracted with irresistible force by whatever was true, good, or excellent. Great characters inspired him with an esteem which he sometimes expressed with incredible ardour."

His works, besides those above mentioned, are, for the most part, compilations and translations. He was the author also of several papers published in the "Philosophical Transactions," the "Memoirs of the Academy of Sciences" at Petersburgh, and those of other learned societies.

FORSTERA, in botany, a genus of Gynandria Diandria class and order. Essential character: perianth double, outer inferior, three-leaved; inner superior, six-cleft; corolla tubular. There is but one species.

FORT, in the military art, a small fortified place, environed on all sides with a moat, rampart, and parapet. Its use is to secure some high ground or the passage of a river, to make good an advantageous post, to defend the lines and quarters of a siege, &c.

Forts are made of different figures and extents, according as the ground requires. Some are fortified with bastions, others with demi-bastions. Some again are in form of a square, others of a pentagon. A fort differs from a citadel, as this last is built to command some town.

FORTIFICATION. During the early ages when the property of individuals was less valuable, or that, owing to the little progress made by mankind in the arts of despoliation and of seizing upon the possessions of their neighbours, the only fences in use were such as sufficed to restrain the depredations of wild beasts, and to prevent cattle, &c. from straying among the scattered patches of cultivation, or into the wildernesses. In proportion, however, as commerce, or communication with others, and the pleasures of society, induced men to build towns and to congregate more generally, the various passions inducing to the commission of that variety of trespasses, which have even, within our own time, increased rapidly, rendered it prudent for each individual to secure his own habitation from clandestine or open assault, and caused the little communities, which every where began to appear, to adopt general means for personal defence, and for the curb of whatever encroachments might be attempted by others in their vicinity.

At a time when the great simplicity of manners gave a limit to the ambition even of the most aspiring, and when science was yet in the womb of time, we may reasonably conclude, that the means of control and of resistance, then in use, were neither costly, laborious, nor very effectual. The details furnished in scripture prove incontestibly, that even the circumvallations used at their date were inadequate to the purposes of security and duration. In fact, the events that shone conspicuous in those times were, with very few exceptions, pitched battles in the open plain, ambuscades, and treasonable conspiracies!

Nor do we find in the more recent histories of Rome, of Greece, of Asia, or of other parts then holding any rank in the military world, much to support the opinion of the ancients having knowledge of fortification. The few places that made any resistance appear to have been principally maintained by the personal prowess of their defenders. Their walls were, indeed, sometimes of great moment, as we see in the instance of Troy; which, if existing in the eighteenth century, would probably capitulate at the first summons.

It was not to be expected that where the powers of demolition were insignificant, the means of resistance would be extended beyond the quantum absolutely necessary. The catapulta, the battering ram, the tower, and such devices, were opposed by heavy masses of stone, or of other adequate materials, on which the besieged mounted to repel the assault. The various contrivances whereby those machines received additional vigour, and the necessity that arose for opposing to their progress more resistance than could be accumulated immediately in their front, (of the tower in particular) first gave rise to the introduction of projections from the even line of the wall, whereby the besiegers could be annoyed laterally, as well as immediately front to front.

Still the engineer confined himself to small projections, generally semicircular, which, for the most part, appear to have been added to the old walls, impending like our modern balcony windows. In the sequel, these towers were built the same as the other parts of the circumvallation, and, like the modern bastion, rested on the terra firma. It however seems doubtful, whether the former mode was not the best,

considering every circumstance attendant upon the ancient mode of assault, and the nature of their weapons.

The invention of gunpowder does not appear to have made any important change for several years, nor indeed until heavy artillery formed a part of the assailants' means, as may be proved by an examination of the remaining castles, towers, keeps, &c. the dates may be traced beyond the middle of the fourteenth century. Such were the solidity and the hardness of many ancient buildings, that the stone shots, originally used, produced a very slight effect; nor was it until iron balls were brought into use, that the powers of cannon were, in any measure, ascertained.

That point being gained, the whole system of defence was necessarily made to conform to the destructive engines which now were added to the common practices of assault. The sword, buckler, lance, dart, javelin, sling, bow and arrow, lost their wonted estimation, and, dwindling into insignificance on the great scale, were reserved for individual contest, or for the lesser purposes of desultory warfare. The great object was to construct such stupendous bulwarks as might not only oppose the newly devised missiles, but, at the same time, support similar means of destroying the invading army.

Hence arose the formation of ramparts, and, gradually, the necessity for deep ditches, and various outworks; whereby considerable delay and difficulty might be created.

The fortifications of the fifteenth century, although to a certain extent new modelled, and made conformable to the necessity imposed by the invention and use of cannon, nevertheless did not display any ingenuity in regard to mutual defence. That great principle was little understood, and the minutiæ of the science remained, for a long time, miserably defective. Men of genius, at length, in part remedied the errors of the old school, and opened the way for that exactness of proportion, and for that systematic arrangement, which characterize the works of modern times. The impregnable fortresses to be seen in various parts of Europe, cannot fail to transmit the names of their several engineers to posterity; unhappily, not unaccompanied by those of the traitors and poltroons who, even since the commencement of the present century, have shamefully abandoned the posts of honour, and yielded to inferior powers.

The immense armies now constantly brought into the field, and the heavy trains of artillery by which they are, in almost all cases, attended, occasion not only an adequate preparation for resistance, but the necessity for establishing lines of communication, of depots, &c. all of which must be on the best construction for defence, containing safe lodgment for a sufficient garrison, together with ample and secure magazines for provisions and for stores. Hence the province of the engineer becomes peculiarly important; it comprizes various branches of information, and requires that readiness of computation, of discernment, and of appropriate resource, which rarely combine in the same individual. The merely planning in the closet, and the laying down on the soil such defences as may perhaps be void of fault, so far as relates to mutual support, and to the great work of procrastination, will avail nothing, if the other essentials are neglected; and even when they are not, the whole may be rendered abortive, and become contemptible, merely from a want of judgment in point of locality.

Fortification is generally considered under two heads, *i. e.* natural and artificial. The former relates entirely to those invaluable situations which, being either completely inaccessible, or nearly so, require but few additions, and demand only such guards as may prevent surprise. For want of that precaution, some posts have been taken, which no army, however numerous and well provided, could have forced to capitulation. Perhaps of all the instances that could be adduced in regard to so fortunate a position as should defy assault, the fortress of Ootradroog, situated in the dominions of the late Tippoo Saheb, sultan of the Mysore, may be justly considered as the most worthy of being cited. It stands on a plain, no hill or eminence of any consideration being within several miles. It is, in fact, insulated, and consists of a solid rock, rising, on an average, about eight hundred feet above the adjacent level; its sides are nearly perpendicular throughout its whole circumference, which measures nearly a mile. The ascent into it is by stone steps, intermixed with occasional breaks for temporary ladders, the whole of which could be destroyed by the fall of a few large stones, always kept on the para-

pet for that purpose. Indeed the interior is lined with such, they being admirably suited to the defence of so peculiar a station. There is no want of cannon on the works, which are ample, and were formed under the direction of a French engineer; they have plenty of water; ample stores kept in immense excavations; and the mos secure lodgment for a numerous garrison. Yet, so soon as the fall of Bangalore was ascertained, this important and absolutely impregnable fortress, to which, perhaps, there exists not a counterpart, surrendered to two battalions of Bengal sepoys.

It would be impossible to afford any instructions regarding those works which may be conjoined to natural defences, so as to render the whole complete; such must depend entirely on local circumstances, of which the skilful engineer will not fail to take advantage.

Artificial fortification applies to every kind of defence, whether regular or irregular, pure or mixed; and has been divided by the most celebrated engineers into two distinct kinds, *viz.* offensive and defensive. The former relates principally to the various works used in attacks and sieges; the latter appertains to the more general purpose of securing towns, forming depots, commanding choice situations, defiles, &c. protecting harbours, and, in general, tending more to self-preservation, and to control, than to the annoyance of others, or to the extension of dominion.

This important science is again subdivided into the permanent and the temporary: the former being with the view to endure the test of ages, while the latter is confined principally to operations in the field; and such works are, for the most part, abandoned so soon as the occasion for their construction may have subsided.

Defensive fortification consists of three systems, each of which has its particular uses:

1. The little which is usually adopted in the construction of works, having four, or five sides, or citadels, various small, or detached ports, horn-works, crown-works, &c. where the exterior of the defences, that is, between the saliant angles of the two bastions does not exceed 350 yards.

2. The mean, which is of general use, and forms a very considerable portion of all regular fortifications, whose exterior sides of defence may be from 350 to about 400 yards.

3. The great, which is principally used where the exterior of the defences measures more than 380, and as far as 500 yards, or perhaps rather more; it is obvious, that such very extensive fronts, even in a hexagon, or figure of six sides, would enclose an immense area; consequently would require a moderate army to man the defences. Hence we generally find this system composing only part of the works; such as are on the borders of a lake, or of a marsh, or along the bank of a river; while the other sides are composed of the second or mean system.

Such are the leading features and applications of the three systems, as settled by the celebrated Vauban, and adopted by the most distinguished professors of our own time. Occasional deviations have, however, been made in several instances, with the approbation of pre-eminent engineers; but, for the most part, such have been with the view of conforming to local necessity, and of effecting a saving, either of materials, where they were scarce, or to disbursement, where parsimony was an object. Anomalies of this description are not to be considered as data whereby to be guided; but it may be proper to study the practical effects of all innovations, however much they may be abstracted from received theories; for the most happy inventions generally experience much opposition, often, indeed, illiberal contempt, while in their infancy. This should not deter the man of genius from ushering his suggestions to the notice of the world; for although his inefficient measures may appear wild and eccentric, or eventually be ignominiously decried by those invincibles, who, having learnt to work "by line, and rule," neither will, nor can, correct their errors; yet there will never be wanting, in this enlightened age, persons who can both comprehend, and duly appreciate, the effusions of a vigorous and sensible innovator.

We now come to the description of the several defences, as regulated by Vauban, and others of acknowledged skill, premising, that many opinions have started, and other proportions been recommended by men of first rate talents, who have each their advocates. What is now offered may be deemed a concentration of their various hypotheses, so far as they could be assimilated into one general system: to give all would occupy volumes.

Fortifications may be considered as regu-

lar, when the enclosed area is of such a form, as can be inscribed in some regular figure; such as a triangle, a rectangle, a circle, or an ellipsis: observing that such figure should, in a manner, fit the town, &c. it is intended to protect. It is usual to divide the perimeter, or whole outline of the figure, when it is either of the two latter forms, into as many faces, or portions, as may admit of suitable defences in either of the three systems already detailed. The number of faces must be regulated as well by the form, as by the extent of the figure. Small circles may be divided into five or six faces; moderately extensive ovals may have six also, while the more extensive circles and ovals will require an additional face or more, in order to reduce the exterior lines of defence within due bounds; so that every part of each face may be within musquet shot of those parts whereby it is flanked, or defended. Whenever this fundamental principle is disregarded, the plan will be proportionally weaker, according to the undue prolongation of the faces, and the consequent deficiency of mutual support.

The several fronts of a fortification may be all dissimilar, both in their proportions and in their extent; as also in the number and construction of their several outworks; yet the whole cannot be termed irregular. Thus the two ends of a long oval may be constructed on the second, *i. e.* the mean system; while each of the two long sides may be upon the third, or great system. One end may have a horn-work; the other a crown-work; the lateral faces being strengthened with ravelines, lunettes, tenailles, or other works; all these are evidently regular members of a perfect whole, and when duly combined, according to the rules of art, form a complete and regular defence, founded on approved systems.

When the number of faces has been adjusted and laid down, it is proper to decide whether the works are to be planned outwards, or inwards, from the line laid down. In the former case much space is gained by keeping all clear within that line, which by this means becomes the interior side: in the latter instance the line becomes the exterior side, all the works being raised within it, which considerably diminishes the area within them. It is to be remembered, that in laying down the plan of a fortification, the several lines, describing the outer part of each rampart, exhibit the situation of a semicircular projection of masonry, called the cordon, which is, with few exceptions, made at the top of their respective facings of stone, brick, &c. called revetements. The line thus following the direction of the cordon, as it proceeds along the works, is called the principal.

A reference to fig. 1, Plate Fortification, will illustrate the foregoing description. The half of a hexagon, or polygon of six equal sides, is selected, as being the most appropriate to this occasion. The line A D, is the diameter of the circle; which circle having been divided into six equal parts, each equal to the radius, or semidiameter, A E, or E D, gives the faces formed by the passage of the rays B E, and C E, through the points of equal division B and C. Let us suppose the fortification to proceed inwards: in such case the lines A B, B C, C D, will be termed exterior sides, and all the principal will be formed within them; whereas, had it been intended to cover more ground, and to keep the whole of the area contained within the lines A B, B C, C D, and D C clear, the principal would have been projected outwards, and the lines A B, B C, C D, would then have been termed the interior side. The former mode is in use when the exterior of the defences is first marked out, and has its separate mode of formation; and the latter is adopted where the interior of the works is established by any pre-existing circumstances, such as fortifying an old town, &c.; and proceeds on a suitable plan of projection. The two modes correspond perfectly, giving the same angles and proportions; the former on a diminished, the latter on an extended scale.

The interior lines F G, G H, H I, form parallel faces with those on the exterior lines A B, B C, C D. If it were required to fortify outwards, they would be the bases of their several defences respectively, and the measurements would be taken from them, in lieu of from the exterior line. We shall proceed according to the latter mode, it being the most common and the most familiar.

To fortify inwards from an exterior line.—Let the exterior line B C, be 180 toises, (each toise being one fathom, or six feet,) bisect it in *d*, and draw the perpendicular *d* 8 equal to one sixth of the exterior line B C, namely, 30 toises. Now from B draw the line B *v*, passing through the point *n*; and from C draw the line C *u*, intersecting B *v* in *n*. Set off 50 toises from the points B and C, on their respective lines, which

are called the lines of defence, giving B *t* and C *w* for the faces of the two bastions. With the opening *t w*, measure *t v*, and *w u*, on the lines of defence, to determine their proper lengths, so as to give *u v* for the length and position of the curtain; next draw the lines *t v*, and *w v*, either curved or straight, for the flanks of the bastions. If they are to be curved, which are generally preferred, the points *t* and *w*, will be the centres of equal circles, whereof the two flanks will be equal segments.

Proceed in the same manner with the other two fronts, A B and C D; you will thus complete two bastions, 3 and 4, and the halves of two more, 2 and 5. Next measure off 15 toises, and draw something less than quadrants, or quarters of circles, from the points B and C; the centres of those quadrants being exactly opposite thereto, place your scale so that you may draw lines from the ends of the quadrants towards the shoulders of the bastions, but draw no further than suffices to touch upon the perpendicular of 30 toises: thus your scale would give the direction, *l w*, but your line would stop a little below *d*. This being done in both directions, and throughout the three faces, will give the width of the ditch, and the interior lines or re-entering angles of the ravelines O, N, K. The body of the raveline is formed by measuring 10 toises on the face of each bastion, setting off from the shoulders *t w* towards the saliant, or projecting angles, (here called flanked angles,) B and C. An opening of the compasses equal to *u w*, (or to *t v*,) with the ten toises included, will give the distance of the saliant angle *o*, of the raveline N, from the centre S, of the curtain *u v*. The sides, or faces of the raveline are determined by lines, drawn from the saliant angle to those points on the faces of the bastions 3 and 4, already set off at 10 toises each, from their respective shoulders *t* and *w*.

It should have been stated, that all angles projecting outward from the body of the place, are called saliant angles: for instance, *s*, B, *t*, of bastion 3, and *e*, *o*, *e*, of the raveline N: while such angles as point inwards towards the body of the place, are designated re-entering angles; such *t*, *u*, *w*, on the lines of defence of the centre face. When an angle re-enters at such a position in the outworks, that its apex, or point, cannot be seen, and consequently cannot be defended from the body of the place, it is called a dead angle. Such cannot easily take place where the smallest attention is paid to the most ordinary rules; but wherever found, should be exploded from the defences, either by cutting off a large part of the pinch, or narrowest part, and substituting a curtain, or by new modelling the defences in that part. It may be proper to observe in this place, that works intended for mutual defence, should never exceed an angle of 120 degrees, nor be less than 60. The medium, *i. e.* 90, which forms a right angle, generally considered, is indisputably the best for the above purpose. Where batteries stand at such an opening, that their direct fire, that is immediately to their own front, is parallel with the front of the part they flank, it is called a razant, or grazing fire; but when the angle is less than 90, so that the direct fire would strike upon the face of the work to be defended, it is termed fishant, or plonging: both have their uses, but the latter is rarely adopted, except from necessity, because a direct fire, at right angles, may be made to plonge, by giving the cannon an inclination more parallel with the side of the embrasure, which being angular, allows a deviation of many degrees from the direct fire.

When two lines form a very acute angle with each other, they no longer are defences; for in case the enemy should carry either of them, he would be able to work its battery against the other line; and though the fire would be plonging, and that too at a great disadvantage, yet as many shots would light within the embrasures, the parapet would speedily be destroyed. The revetement, or masonry, in the front of the line so plonged, would not be much hurt, as it would turn off the shots.

Before we proceed farther, it is expedient that the reader should examine the line of the principal, following along A, *o*, S, *r*, *s*, B, *t*, *u*, *v*, *w*, C, *b*, *y*, *z*, *m*, D; in all which he will perceive, that every part is made to flank some other. The ravelines O, N, K, will be found to give great security to their several curtains, *s r*, *u v*, and *y z*; while at the same time they would enfilade whatever approaches might be made towards the saliant angles of the bastions. In examining these circumstances, all the other outworks must be exempted from consideration; our view must be confined to the manner in which the gates in the curtains are protected; the flanks of the bastions concealed from every part, but the line of their direct fire; and the spaces opposite the saliant angles, subjected

to a heavy cross fire. The ravelines, themselves, stand at too wide an angle to absolutely flank each other, but they are capable of scouring the glacis reciprocally, and would, as before remarked, subject the besieger to a dangerous enfilade, or flanking fire, were he to proceed without due attention to their obnoxious positions. In works of more sides, where the angles of the bastions are necessarily more obtuse, the ravelines are thrown more towards a right angle with each other, and afford mutual support, even in cases of assault.

The communications with the ravelines are effected by the aid of bridges, when wet ditches are in question, as may be seen in the third face, *y z*, where the bridge V is carried over from the curtain to the counterscarp, or outer face of the ditch, so as to afford access to the raveline K, in which is the intrenched redoubt L. The double lines T, represent a channel of about 14 feet broad, and about 6 or 7 feet deep, made in all ditches that are at any time filled with water. These channels are called cunettes, or cuvettes; they are usually lined with masonry, and kept full, so as to prevent a surprise: when the water is allowed to fill the whole of the ditch, which should generally be to the depth of 9 or 10 feet, or at all events so as not to be fordable, the cunette proves a formidable obstacle.

The bridges have barriers at their outer ends, and towards their inner ends generally a drawbridge, besides one that lifts immediately under the gateway, to which it gives additional strength. The very small compass allowed for the exhibiting of such figures as are indispensably necessary towards the right understanding of the subject, absolutely precludes the possibility of shewing the dimensions of the ramparts, &c. and occasions the omission of many particulars in the plate, which must be therefore described. The foregoing impediment prevents us from shewing the berm, which is a space, always left, between the cordon that runs along the inner brink, or scarp of the ditch, and the foot of the ramparts. Its use is to prevent the latter, when battered, from falling into the ditch; and it affords likewise a very good line of communication all around the works. The breadth of the berm is very uncertain; it should never be less than six feet, even where the works are scarp'd from the solid rock, and not subject to let fall much rubbish when battered. In the common mode of building ramparts with a revetement of masonry, the berm should be at least 10 or 12 feet; and where only turf facing is used, or that the soil with which the rampart is filled, between the outer and inner faces of masonry, is of a loose nature, the berm should then be full 20 feet broad. The bulk of the rampart should, however, be considered, also whether it be much exposed or not; for on these points much will depend as to the probable quantity of battered rubbish to be sustained. There used to be a work, called the fausse-braye, carried all round the principal and the edge of the berm; its intention was to defend the ditch, and its fire was indeed highly destructive; but the facility with which it could be enfiladed, for it was necessarily low, evinced its inutility in general: the immense number of splinters falling from the rampart, immediately above, was another formidable objection. The fausse-braye is, therefore, out of repute; though in some fortifications, a substantial parapet supplies its place, generally of masonry, more for the purpose of stopping the rubbish of a battered rampart, than for the means of sheltering troops. Perhaps the strong hedge, adopted in many instances, may be preferable; to say the least, it is far cheaper, and stands to more advantage on the berm, than a heavy range of masonry.

The first draw-bridge generally connects with the body of the bridge passing over the ditch, and is drawn up by persons standing on the berm; while that draw-bridge, which rises close up against the gate, is so contrived as to bury itself, for at least its whole thickness, into the masonry; whereby its edges are secured from the grazing of shots, ranging against the wall, and the possibility of wrenching the draw-bridge out of its place, is sufficiently obviated. The gates usually close in the ordinary way of all large ones, *i. e.* in two leaves, meeting in the centre; over them a portcullis is sometimes suspended horizontally; its hinges being close behind the gates when shut. This immense machine resembles a very large harrow, and lets down, much like the ports of a ship, until it hangs vertically, close at the back of the gates, and being secured with long iron stays, beams of wood, passing like window bars into the wall and other devices, it proves adequate to the repulsion of even a common sized petard. Some places have a succession of such gates and portcullises one

behind the other, which added to the casemates being lined with defenders, renders it almost impossible to force these passsages. When matters are driven to extremity, owing to the raveline being possessed by the enemy, and by the defences on the curtain and flanks being rased, the gateways are then filled up with rubbish, either loose or in bags, &c. so that they are no longer passable.

The nakedness opposite the angle B, of bastion 3, is left purposely to shew how easily a besieging army would effect a break at that angle, provided no additional outworks were supplied; for, as yet, we are to consider the fortress to consist only of the principal and the ravelines. A suitable train of battering cannon brought to act upon the point B, while other batteries were employed to silence the faces of the adjacent ravelines O and N, would, in a very few days, effect a breach, and give the besiegers a command of the ditch, by establishing themselves in a lodgment on the crest of the glacis *g*, at the saliant point *q*; whence they would batter the flanks *o* S, and *w v*. Then, as nothing could oppose their passage over the ditch, which if wet would be passed by sap, (*i. e.* by filling up with fascines, &c.) the angle B would be carried by storm: for the matter would obviously rest on the numbers, and on the personal prowess of the contending forces. The issue of such affairs have been so various, that it would be presumption to say the besiegers must succeed; but if the breach be practicable, and the internal state of the bastion, as seen in No. 3, even though there should be an intrenchment of the gorge, *i. e.* from *r* to *u*, the chances would be in their favour, after the breach were gained. This mode of defence is perhaps the best in hollow bastions; that is, in such as are not solid, but have deep areas within them, level with the streets of the town, &c. (called the terre-pleine;) but in a solid bastion, some defences should be internally constructed while the breach is making; of this some idea may be formed by the flanked angle in bastion 4, where a rampart and ditch are made, to force those who may ascend the breach to quit the bastion. The gorge may also be fortified as in bastion 3, whereby much time may be gained, a matter often of the utmost importance, either from the expectation of succours, or to favour the evacuation of the fortress altogether.

In bastions No. 3 and 4, the flanks *t u*, and *w v*, are not only curved, but they are double, presenting, of course, two tiers of cannon, of which the upper stand on the bastion, while the lower are just below the level of the berm, whereof they constitute a part, and cannot be discovered beyond the crest of the glacis. These latter, therefore, cannot be battered from the approaches in the early stages of a siege; they lay, as it were perdue, in reserve for the defence of the ditch. There are two little semi-circular projections at *t* and *w*, called orillons; these serve, not only to cover the flanks *t u* and *w v* from enfilade, but each mounts a gun which cannot be perceived until half way over the bridge, and which serve to defend the gate when assaulted, as well as to take the assailants in flank, and partly in reverse, (*i. e.* from behind,) as they advance to the attack. They are especially useful when a tenaille, as seen at P, is constructed in the dry ditch before the curtain S *r*; for when those who were placed in the tenailles, which command the interior of the raveline O, and of the redoubt Q may be attacked in flank, and be obliged to retreat into the principal, along the caponnaire P △, these guns pour in grape along the interior of the tenaille, when it is in the hands of the enemy, and enfilade so as to cause its abandonment.

The caponnaire is a passage made between two parapets, each having a long talus, or slope, outwards; as expressed by the small lines diverging from the path. It is commanded by (*i. e.* open to the fire) the flanks *o s*, and *s r*, and the centre of the curtain *s r*. Demi-caponnaires are common for the passage of troops from one outwork to another, as seen at *e e*, in the raveline N, where they serve to shelter the narrow defiles leading into the intrenchments *ff*, within the crown-work M. They have but one parapet which is open to the fire of the faces B *t*, and *w c*, also to the oblique fire of the curtain between *u* and *v*. By their exterior slope they serve to flank the passage of the ditch of the raveline, in conjunction with the faces B *t*, and C *w*, which fire over them, and command the whole interior of the horn-work M.

Having established, by this exposition, the absolute necessity for adding exteriorly to the defence of the principal, we shall now proceed to give a general insight into the various modes of constructing the other outworks; all being so designated which do not come within the principal, or body of the place. The reader should understand,

that every out-work, as it is placed more distant from the principal, must have a less elevation from the terre-pleine, or level of the area, on which the walls of the principal are founded. Thus we find, that a line drawn from the foot of the glacis *g*, at Φ opposite to the flanked angle of the bastion C, in the horn-work M, carried through the centre all the way up to E, which is the centre of the polygon, should graze the crests or inner summits of all the parapets standing in that line: this is called the defilement of the ramparts. By such a construction it must be obvious, that every added work is a screen to, but is commanded by that within it: thus, the bastion C, in the crown-work M, is a screen to the raveline N, and that again to the curtain *u v*; while the intrenchments *f f*, correspond in height with the flanks of the hornwork, so as to be under the command of the raveline, though they command all that portion of M which is in their front; and would continue to do so until the besiegers should construct batteries in the gorges of the bastions *b*, C, *b*, or elsewhere, and render *f f* untenable.

The angle C, of bastion 4, is covered by the counterguard 7, which not only has that effect, but protects the adjacent tenaillon R, and can plonge upon the adjoining flank of the crown-work M. As a still further covering to the bastion 4, a fleche 9 is added, parallel to the counterguard 7, at the foot of its glacis, serving to render the attack more tedious and difficult, by compelling the besiegers to commence their approaches at a greater distance, where they are more generally subject to the fire from the bastions, &c. of the crown-work. The fleche (*i. e.* arrow-head,) should properly extend equally each way, having both faces alike, but that is not of any moment, and might have a second glacis; it is connected with the counterguard, or with the crown-work, or with the tenaillon, by means of a sortie, or winding passage cut through the glacis, or by a caponnier, as in the plate, intercepted with traverses, which will be duly explained when treating of the covert-way.

The raveline K is defended within by the redoubt L, surrounded by a dry ditch. This redoubt should not be too high, because it would else serve to shelter the enemy in case they should succeed in silencing the faces of C 6, and *m* D, of the corresponding bastions 4 and 5. The small work S is a lunette, which must be carried, or silenced, before the raveline can be breached in that part; and, indeed, before any lodgment can be made opposite to the flanked angle D, of the bastion 5. The lunette must be lower than the raveline, from which it properly derives its defilement, as will be hereafter explained.

The tenaillon R is a very important conjunctive to the raveline K; it, in fact, doubles its force on that side, and prolongs the battery of its other face; it flanks the counterguard, and its direct fire is a great protection to the demi-bastion *b*, on that side of the horn-work, as well as to the whole face of its raveline *a*; it commands the fleche; and being itself commanded by the raveline K, and by the face C 6, and the counterguard 7, cannot be occupied by an enemy while any of these three works remain in force.

With respect to the construction of the counterguard, lunette, and tenaillon, they are not upon any exact scale in proportion to the principal, as the raveline is, but though not perfectly arbitrary, their formations depend on some general rules, which should invariably be had in view. The counterguard is always placed on the counterscarp, its front immediately behind the glacis, and its rear, generally being a continuation of the revetement of the counterscarp, so that the passage lays along its terre-pleine, or battery. This kind of work may be of any extent, that is, it may proceed from raveline to raveline without interruption; or it may break off where it enters a lunette, a tenaillon, or a redoubt; or it may be only formed of two parallels equal in length with the faces of the bastion. On account of the number of men required for the defence of extensive outworks, counterguards are advantageously made hollow, having casemates covered with bomb-proofs, their parapets being solid masonry: their entrances, at each end, are secured by barriers and drawbridges; and their walls may, in places, be pierced with loop-holes, through which musquetry may be discharged against assailants.

Casemates are likewise made on each side of the posterns, or arched passages through the faces of ravelines; there are always drawbridges and barriers in such situations, as also at the cuts through the lunettes, &c. which lead through the covert way to the esplanade, and are called sorties. The necessity for casemates must, generally, depend on the quantity and distance of out-works from the body of the place:

it should be a rule never to place an outwork so that it could be cut off, without receiving aid from some sufficiently strong and contiguous part. Were this neglected, the enemy would not fail to surround such ill judged detachments, and to a certainty carry them off during the night. Admitting this principle, the fleche 9 would be subject to the foregoing evil, if there were not a strong body of troops stationed in the counterguard 7, or the flank of the crown-work, from which detachments could be sent without delay.

Lunettes are generally constructed by producing their faces at about one half the length of the raveline, which they flank at right angles; their own flanks are drawn perpendicular to the face of the bastions which commands them, generally falling about the middle of such face. See the lunette *s*, opposite the bastion D. Sometimes the lunette is separated, by a narrow fosse, from the body of the raveline; in other instances, its face joins that of the raveline; the fosse being arched over, and a battery placed on the arch, by which the ditch of the raveline is scoured. The face of the lunette gives a direct fire towards the glacis, before the saliant angle of the bastion 5.

Tenaillons, (signifying piercers, or claws,) are sometimes made on each side of a raveline, and even beyond them a small detached raveline, or a bonnet, is sometimes added. The rule for constructing a tenaillon is, to prolong the other face of the raveline, thereby to make its front, and to determine the length of that front, by a flank drawn perpendicular to the centre of the face of that bastion, before which the tenaillon stands; as is seen in the tenaillon R, standing in front of the bastion 4, and covering the face of the raveline K.

Redoubts standing in ravelines, being intended as a resort for the troops driven from the defences of its faces, and requiring great strength of defenders, should invariably be casemated throughout, in the most substantial manner; they may not only mount batteries on their ramparts, which should command those of the ravelines wherein they are placed, but they may be pierced below with abundance of loop holes, and with embrazures for cannon, provided the ditch be of a sufficient depth and width to prevent assault, and that the interior of the raveline be, as it ought, perfectly level, and contain nothing to conceal the enemy: in each redoubt there should be a small expence magazine, and in every outwork one or more wells should be made, if practicable, of sufficient capacity to supply plenty of water.

Redoubts made to flank other works can have no fixed rule; they are generally placed to most advantage, and their fronts are always disposed towards those parts of the exterior, which stand in need of such support. In some places, as at Q, they are made more to cover a weak point, than with any immediate view to protracting the assault: the want of a redoubt, or some other work, on the other side of the bastion O, serves to prove the utility of that at Q; it being evident, that could an enemy's battery be placed any where about C°, C°, that is, in a position to batter the bastion 3, the greater part of the defences of the principal would be subjected to mischief; and that, as the approaches should advance upon the glacis, the ravelines N, and O, would be in a measure cut off from all connection with the curtains S *r*, and *u v*. We suppose the crown-work M not to exist.

We now come to speak of that crown-work; it is a limb of immense importance, and should be rendered as strong and efficient as possible. This kind of fortification is built on various accounts, *viz.* to occupy ground which, being left at the disposal of an enemy, might prove of considerable injury to the body of the place; to enclose buildings that could not be included within the principal; to defend a promontory, or a projection, covering a harbour; to prolong a line of works, and other causes which locality would suggest. When, however, a piece of ground, which stands higher than could be commanded from the works of the principal, is to be occupied, a crown-work would be improper; in such case, a citadel is advantageously made on the superior ground; observing, that in lieu of a raveline being at N, there should be a complete defensive face, appertaining to the citadel, commanding the works of the fortress, which instead of presenting defences along the centre face B C, should rather lay open to the batteries of the citadel. These latter should command the whole interior of the polygon, and be well casemated throughout, for the safe lodgment of all the garrison, and for the safe keeping of provisions and stores, for six months at least. The instances on record of citadels holding out for a long time, should render

their use more common, especially where the ground favours their command of all the other works.

Although we have, in tracing the defilement of the ramparts, from the point Φ, to the centre of the polygon E, laid it down as a general rule, that the ascent of the works should assimilate to that line; yet in such very spacious defences as crown-works sometimes are, (for their area is occasionally equal to a third of that within the interior line of the polygon,) some exceptions will take place; especially when the ravelines opposite to the faces of the crown-work, are defended by still farther advanced out-works: then the angle of defilement would be so acute, from the terre-pleine, or horizon, as to cause scarce any difference between the heights of the ravelines, and of the bastions of the crown-work: a matter of obvious impropriety. Hence, it is often necessary to give the ramparts of a crown-work, rather more height than the line of defilement might allow; raising the raveline and its intenchments suitably, and making cavaliers, as instanced in the bastion C, of the crown-work, on the solid bastions 3 and 4, so as to command the whole of the crown-work completely. A moineau, or flat bastion, of similar height with the cavaliers, may be made in the centre of the curtain *u v*, for the same purpose.

Cavaliers are of singular use on many other occasions, to which their form should be accommodated; that in the bastion *c* of the crown-work, is, from its shape, termed a horseshoe; the flatness of its front is applicable to the situation it there holds, because it opposes a direct fire towards the point Φ; but its circular tendency gives its front a bias towards the inner parts of the faces of the ravelines, while its flanks present a direct fire into the ravelines themselves, and give an oblique fire into the opposite ditches, whereby the assault of breaches in the saliant angles of the demi-bastions *b b*, would become very hazardous.

The proportions of a crown-work must depend greatly on the purposes for which it is erected, but whatever be its object, the whole of its defences should be commanded by the works of the principal in so complete a manner, that no part, whatever, should offer an asylum to the enemy, after carrying it; and consequently, that none of its batteries should be able to play into any other of the defences. For the loss of so large a limb, and of the many serviceable cannon, platforms, &c. which, in such case are invariably, and actively employed against the body of the place, is a very serious concern, and requires the utmost exertion to oppose even for a time. On this account it is highly necessary to have mines under all those parts which can prove serviceable in the smallest degree to the enemy, and to blow them up whenever a favourable moment may present itself.

From what has been stated as to the purposes of crown-works, it will be seen, by reference to that laid down in the plate, that much attention is requisite to give them every defensive property, while on the other hand they should prove of little value to a successful assailant. The only work in our plan affected by such a circumstance, would be, that the counterguard 7 would be untenable as a battery, though it might retain some small utility as a casemate. But by mining all the inner part of the flank, which commands the counterguard, even that evil would be lessened; if, however, an enemy should be able to carry the raveline N, and to maintain his ground therein, notwithstanding the tremendous fires from the faces of the bastions 3 and 4, and from the curtain *u v*, (all of them direct) but little hope could remain of a successful resistance, and the counterguard would be, comparatively, no sacrifice. We, however, see from this, that a tenaille on the lines of defence *t*, *u*, *w*, as shewn at P, between the bastions 2 and 3, must prove highly serviceable, especially if mounting such heavy metal as would destroy any works thrown up in the raveline N.

The intrenchments *f f*, cut the ramparts of the flanks of the crown-work through all but the revetement, and they are carried as far forward as possible, so as barely to be flanked by a barbet battery in the saliant angle of the raveline, that the bastions of the crown-work may be perfectly commanded by musquetry. The cavalier in C, is supposed to be mined and destroyed, else it would prove very disadvantageous to the defence of the raveline, which it would partly command.

We have already observed, that many out-works might be shewn in addition to those given to the faces of the crown-work, such as lunettes, tenailles, tenaillons, fleches, advanced lunettes, redoubts, bonnets, &c. but we apprehend the reader will, from the foregoing details, and the plate to which they refer, be able to supply to his imagination, the almost endless continuation of out-works, which the limits we are compelled

to draw around this branch of science preclude us from enlarging upon.

The bonnet mentioned in the preceding paragraph, is nothing more than an angle made parallel to a raveline, and not far removed from it, so that the faces of the latter command the faces of the bonnet. This out-work comes down to the lunettes, by which it is flanked.

We now have to treat of those important parts the glacis, and the covert-way. The former is a gradual slope, commencing at a distance from the exterior of the outworks, seldom less than fifty yards, and when within five toises of the ditch, stops abruptly, occasioning a sudden fall, never less than seven, nor should it be more than nine, feet. Here it is supported by a revetement, and is partly met by a banquette of turfed soil, which is raised high enough to come within four feet and a half of the crest, or highest part of the glacis. At the foot of the revetement, at such distance as may prevent an enemy jumping over, say from two to three feet off, a row of palisades is fixed; these are strong pales nine feet in length, of which one third is buried in the banquette, while the long horizontal rails to which the palisades are firmly nailed, are at every ten feet morticed into square ports. The lower rails are one foot from the banquette, and the upper ones are just level with the crest of the glacis, so that the soldiers may fire through the top intervals between the pales, resting their pieces on the upper rail.

The primary defences are in the covert-way, but they are only for musquetry; as this part, owing to its laying very low, is subject to be enfiladed, and also because the saliant angles of the covert-way are sometimes abandoned from various causes, there are at every forty or fifty yards parapets, whose slopes point towards the exterior, or saliant angle of the covert-way, so that cannon shot may be stopped, and the defenders may make a stand from time to time, behind these parapets, (which are called traverses,) until at last forced into the out-works for safety from the pursuing enemy. Each traverse is made the whole breadth of the covert-way, namely, 30 feet; their exterior ends would touch the palisades, were not little inlets made at right angles into the crest of the glacis, broad enough for two or three men to pass abreast. The traverses may be about six feet high within, and about five without; there is a banquette within which raises the defenders about a foot and a half, for them to stand upon, and to fire over the parapet, of which about ten feet is generally the thickness. Another method of passing the ends of the traverses is not uncommon, and is, perhaps, at least equally good as the foregoing; this is by making a serrated line of palisades, as seen in the plate, in which the small black projections from the line of the ditch, represent the traverses, and the line bordering the glacis *g*, *g*, *g*, shews the line of the palisades; not unlike the teeth of a key-hole saw. The vacant spaces +, +, +, +, in the re-entering angles, are for the assembling of troops for the defence of the covert-way, and are called places of arms. In these, sometimes, small redoubts are thrown up. Places of arms are always near to some sortie from an outwork, so that the parties posted in them may be readily withdrawn, or be reinforced; in some instances, however, places of arms are made in the saliant angles of the covert-way; but they should then be in some measure entrenched, or protected; else they would be severely, and perhaps unnecessarily exposed, although the covert-way is so far above their heads.

The glacis is always made so as to give an inclined plane, corresponding with every change of direction in the line of the crest of the glacis; not, however, adverting to the small inlets, or serrated appearance, required for passing the ends of the traverses. This will be seen on reference to the plate, where every such inclined plane is particularized. Such a disposition of the glacis is indispensable; it gives the true direction of every part, as it respectively stands fronting to the line of palisades; so that the soldiers can scarcely fail to aim properly if they fire straight before them, and rest their musquets on the upper rail. They thus graze the surface of the glacis, and consequently do great execution.

An extensive defence, called a horn-work, is sometimes substituted for a crown-work. The latter, as may be seen, is composed of a full bastion between two curtains, whose exterior sides are terminated by demi (or half) bastions; whereas the horn-work, in lieu of expanding as it recedes from the principal, contracts, and its front, (which should be parallel to that of the principal when it covers a curtain therein,) is formed only of a curtain, terminated by two demi-bastions. The out-

works beyond its ditch may be very numerous, though not so varied as those placed beyond a crown-work.

The object of both these defences, generally, is much the same; when a small diminishing tract is to be covered, the horn-work is proper, but when a round, or rather encreasing spot is to be enclosed, the crown-work should be preferred. The intrenchments within a horn-work are, however, the strongest, because they oppose a larger front against a smaller one; which is the reverse of what takes place in the crown-work, where the intrenchments *f f*, are narrower than the front, which can be opposed to them between the flanked angles of the demi-bastions *b b*.

The explanation of fig. 2, next demands our attention: it is the profile of the principal, and of the proximate outwork. In this, not only the defilement, but the deviations from the terre-pleine, or line of the horizon, whether by superstructure or by excavation are shewn.

A, represents the rampart of the principal, or body of the places of which the measurements may be in general terms taken at the following computation. The height of the terre-pleine H, on which the cannon are mounted, 20 feet; the banquette I, on which the soldiers stand to fire their small arms, raised 3 feet above H; the point X, which is the crest of the parapet, being $4\frac{1}{2}$ feet above the banquette I, and $7\frac{1}{2}$ above the terre-pleine, H. The upper part of the parapet is lower without than it is at the crest X. This declination, which is called the superior slope, is at the rate of one inch for every foot the parapet has of thickness, so as to allow the defenders to fire at an enemy almost close to the rampart, yet not to weaken the crest. K, shews a revetement of masonry, which should be five feet thick at the top of the rampart, not including the parapet, but measuring at the upper cordon O. The exterior slope of the revetement should be one sixth of its height, taken from the foot to the cordon. The foundation should project in proportion to the height, and to the nature of the soil. The interior slope of the parapet, and the banquette, are likewise bounded by a revetement in this figure, but such is not always the case, when it is, the ascent to the banquette is made by two or three steps, as here shewn. Nor are all parapets faced with masonry; the generality, indeed, are gazoned, or turfed, on account of the incalculable injury done by the splinters, knocked off by such shots as graze upon masonry of any kind. In some instances, only half revetements are used, that is, only for the scarp, or face of the ditch, as seen at M under the córdon O; the whole exterior of the rampart itself being gazoned. The interior slope of the rampart, when made of masonry, as seen at P, where the counterscarp is carried up, or built upon, to form the interior slope of the counterguard B, may be equal to only one-fifth of its whole height; but where masonry is not used, the interior slope, as at L, of the rampart A, should, if the soil be firm, be equal to the height of the rampart, which would give an angle of 45 degrees; when the soil is sandy, crumbly, or apt to give way, the interior slope should be equal to a height and a half, or even more, if circumstances should require. The continuation of the revetement M, above the cordon O, which is level with the terre-pleine of the berm N, is a firm parapet, made in lieu of the exploded fausse-braye, to prevent the ruins of the rampart A, when breached, from falling into the ditch C; of which the breadth is indefinite, though from 15 to 25 toises may be considered as the limits for works according to the mean, and great systems of Vauban. About the middle of the ditch, but generally rather more towards the counterscarp P, than towards the scarp M, is the cunette, or cuvette, about 15 feet broad, reveted throughout, and from six to nine feet deep. It is always kept full of water, where that may be practicable; and as it goes entirely around the body of the place, serves to prevent a surprise, to restrain from desertion, also from an improper access to spiritous liquors, and as a drain to the body of the ditch. In many instances, very fine supplies of fish are obtained from the cuvette. In some fortresses it is cut off from before the curtains by rows of pallisades, standing on a shelving work, called a batardeau. Where it is continued before the curtains, there must be bridges of communication; and small temporary plank passages are made over in various parts, when occasion may require. All ditches should be sown with good grasses, that they may give a supply of that valuable commodity to such horses, &c. as may be kept in the fortress; and all gazoned facings, as well as the slopes of parapets, should be regularly mown for the same purpose.

The counterguard B is solid, as is also the rampart A; its terre-pleine H is consi-

derably lower than that of A, which command it, both by the cannon it mounts, and by its musquetry; the parapet being sloped so as to give a direct fire into it, when the firelocks are laid upon the slope at *x*. In this counterguard the interior of the parapet is not reveted; therefore the banquette I is ascended from the terre-pleine, H, by a slope of gazon. The parapet C, &c. are nearly of the same dimensions as F on the rampart A, except that the rampart B is much lower than A. The exterior of B has a cordon, level with the terre-pleine H, but its parapet is faced with turf, which the cordon assists to support. If the counterguard B were not defended by other out-works in its front, it would have a glacis come close to it, leaving only a very small passage between its exterior and the palisades; here we suppose it to have a small dry ditch D, reveted both in the scarp and counterscarp, but without a berm, which is very rarely, if ever, allowed to an outwork.

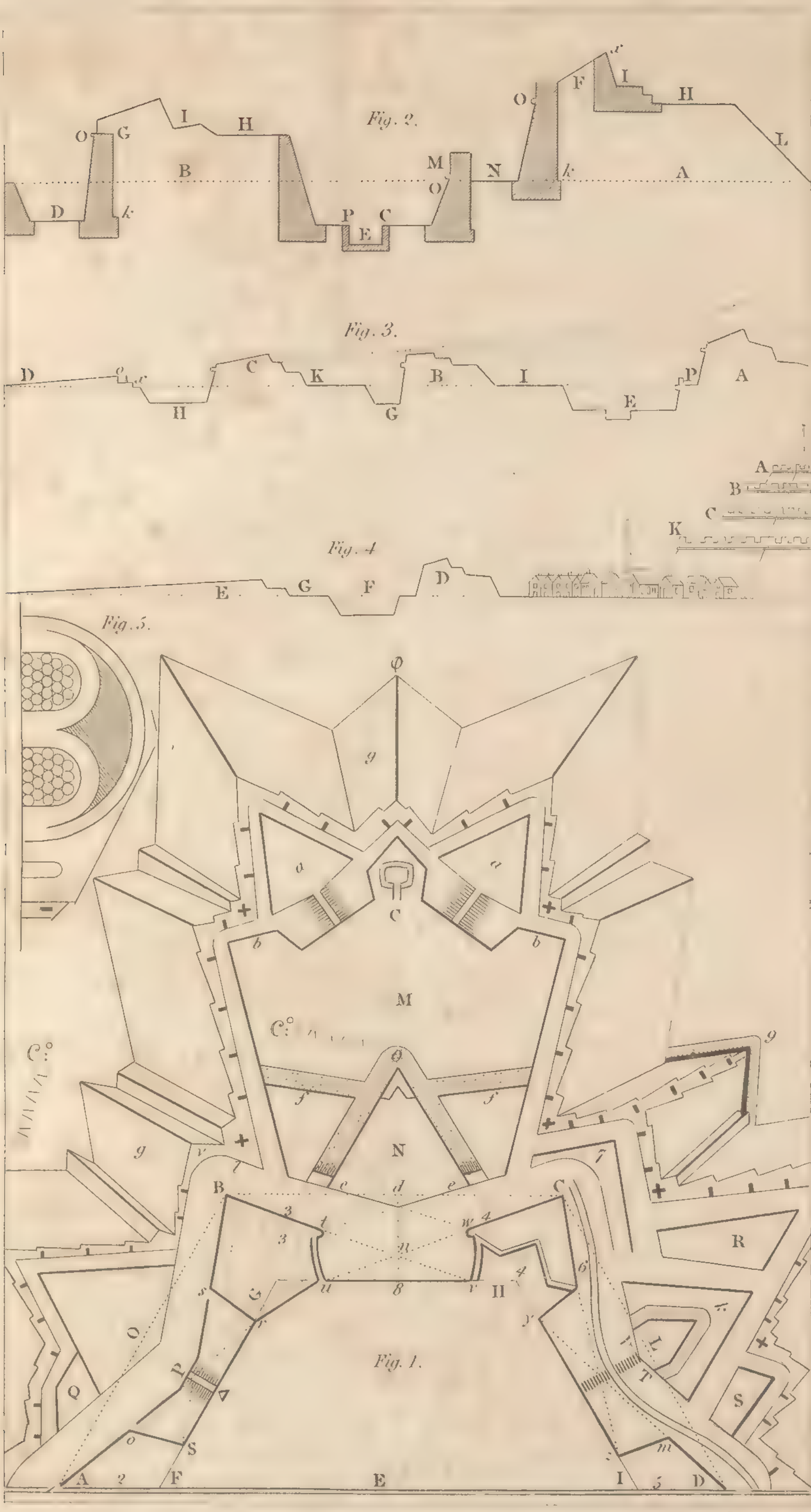
The third figure affords a more general profile of the works, and gives some idea of the usual defilement of the outworks, B and C, from the body of the place A. D is the foot of the glacis, where it meets the terre-pleine, or level of the country, which we always suppose to be esplanaded, (that is, laid flat) and not affording any cover to the enemy for at least 1000 yards from the outworks. The glacis is usually made full 50 yards long, and of such an ascent as to give, on an average, about eight feet height at its crest. Supposing the angle of the raveline to be 25 yards within the crest of the glacis, the continuation of the ascent would strike the cordon of the rampart, C, at 12 feet from the level of the terre-pleine; this determines the height at which a cannon, standing on the terre-pleine of the raveline, C, would graze the glacis, while the slope of the embrasures would allow the guns to play into the covert way. It is to be observed, that, according to this construction, all the scarp, below the cordon, is completely hid from the enemy, and cannot be battered so long as the crest of the glacis remains at its proper height. Hence partly arises the great difficulty of breaching the saliant angles of outworks.

Now let us estimate the redoubt, B, at 25 yards within the flanked angle of the bastion, C. It is to be remarked, that this defence is made with the view to render the raveline untenable to an enemy; and that, for the preservation of its parapet, the rampart of the redoubt, B, should be a mere trifle above the level of that of the raveline, C. The faces of the contiguous bastions of the same front, enfilade the faces of the raveline; but it is also requisite, that the fire from the curtain should, on emergency, (for the bastions may be silenced) contribute to drive the assailants from that part of the raveline which lays beyond the redoubt, at all events to clear its ramparts. Therefore, we will state the terre-pleine of B, at only one foot above that of C. This puts the redoubt completely out of the line of defilement, and, in fact, generates another, by allowing the curtain, A, to throw shot into C, without touching any part of B, as may be seen by following the line from the cordon of A to the terre-pleine of C. Hence B cannot be battered from the glacis.

But where it is necessary to produce the greatest accumulation of strength against any exterior point, it is often found proper to raise every part of the interior defences, so that they should all overlook like a flight of steps, as shewn in fig. 4, where the citadel is supposed to stand on a conical hill, high above the town, (which is only defended by a glacis and covert way, surrounding a ditch and rampart) and has four rows of cannon, at different heights, each commanding the exterior defences, and the surrounding country, as far as the shot can reach. This, though not a common figure, nor a common mode of fortifying such places, (for works are rarely carried like hoops or bands around hills) will fully illustrate the general tendency of the foregoing details, and to the ordinary reader, who cannot here expect to find all the minute items and varieties abounding in this very intricate science, will give a tolerable insight into the principles on which fortifications are usually constructed.

To return to fig. 3. It will be seen that the elevation of A would, on the calculation there assumed, be such as to carry the cordon of its terre-pleine so high, that its revetement could be battered from the glacis, D O, without touching C or B. To remedy this, where such an exposure would be injurious, (for it is in some instances expedient, as above described, to direct all the force exteriorly, especially where the outwork lays upon a navigable river, and that ships can be brought to bear upon the works,) the redoubt must be lowered to the same level of terre-pleine as the raveline; and, indeed, it may even, in some few in-

FORTIFICATION.



Lowry sculp.

London, Published by Longman, Hurst Rees & Orme, June, 1808.

stances, where A must be completely screened from the exterior, be proper to sink the terre-pleine of B so very low, that its cannon may just graze the terre-pleine of the raveline, C; making the parapet of a due height, and forming a substantial shed of three inch boards, &c. nearly flat, over the banquette, at a foot above the crest of the parapet. This prevents the enemy from commanding the terre-pleine of the redoubt, while, at the same time, those defending it, would do ample execution through the narrow slit, or opening, between the crest and the shed. The latter would effectually keep off grenades, &c. and give the defenders great confidence. The dotted lines above the rampart, A, shew the height to which its parapet would necessarily be raised, if B were elevated even a foot and a half only above C. The dotted line from C towards B, shews the level to which the genouliere, or crest of the lower slope of the embrasure, may be brought, so as to allow the fire from B to graze the terre-pleine of C, and to drive the enemy from the raveline.

Relinquishing the explanation of what relates to the more scientific parts of the topic, we must now enter upon the description of many other matters, indispensably necessary on this occasion. We have already spoken of bomb-proofs. These are vaulted chambers, either running under long arches, or groined, and standing on substantial walls and pillars. The term very properly implies, that the arches should be sufficiently strong to resist the fall of shells, or, at least, to prevent their penetrating into the chambers. It generally demands, at least, a yard in thickness to produce such a firm resistance; the masonry should be of the very best materials, and put together in a workmanlike manner. The casemates, thus arched over, should be further covered with three or four feet of soil, where such an addition would not raise the terre-pleine too high; for, by allowing a shell to bury itself completely, its splinters do not occasion half so much mischief, as when the explosion is more superficial; although a quantity of soil may be thrown out. Perhaps the best contrivance for small casemates, defended by breast-works, is the giving them such a slope, as may cause shells to fall into pits, &c. so as to do no damage. Such pits answer well in the centres of round or polygon redoubts, where only a parapet is left around the top, and might, perhaps, be advantageously made in the centre of block-houses, &c.

In the formation of magazines, for ammunition, the arches are usually made double, that is, one greater arch covers two smaller ones; the latter resting on a central pier, as seen in fig. 5. In this case every arch should be bomb proof, and the roof should be pitched; the end falling off by a gradually rounding, and the whole well supported by buttresses. The walls of magazines are generally double; the buttresses are sometimes pierced at their sides with small loop-holes for the admission of air and of light to the surrounding passage. All the fastenings should be of brass or of copper, and no wood or iron allowed in any part whatever.

The ramparts are ascended by means of long slopes, called ramps, laying in general parallel with, and leaning against them; these ought always to be broad enough to admit a gun passing up and down, mounted on its carriage. The ramps into solid bastions sometimes diverge into three branches, of which two lay along the insides of the adjoining curtains, while the third runs straight up in a line with the capital, *i. e.* with the centre of the gorge, pointing towards the saliant angle. Thus H C is the capital of the bastion 4, fig. 1. Horse-shoe cavaliers have usually but one ramp, placed in the centre of the rear, as shewn by the two parallel lines proceeding from that in the bastion, C, of the crown work, M, fig. 1.

The proper arrangement of streets, within fortified towns, is of the utmost importance, by contributing essentially to the ready resort of troops to their posts, and facilitating the supply of stores. Every avenue ought to have a barrier, both to keep the inhabitants under proper controul, and to prevent the effects of various stratagems in behalf of a surprise. Those houses which command the interior of the works should be always reserved for the habitations of the garrison, and should likewise be supplied with small quantities of ammunition. The arsenals should be completely covered from the fire of the enemy's batteries; and, together with every building appropriated to the lodgment of troops, or of stores, &c. should be covered in with bomb proofs. The magazines should not be too large, but commodiously situated for the distribution of ammunition, and every precaution should be taken to keep all combustible stores, as

far as possible, from the provision, &c. so that in case of the former taking fire, the garrison should not be necessitated to capitulate, owing to a want of subsistence.

Sally-ports are made, under various parts of the works, to favour the sallies made occasionally, for the purpose of attacking the besiegers in their intrenchments, or for other essential purposes. These are generally galleries, which are shut up, except at the moments when in immediate use. Mines are frequently prepared in the first construction of a fortress; but the galleries whereby they are entered, are usually stopped up; nor are they loaded, that is, filled with powder, until the period seems close at hand for their being serviceable. Such matters are carefully concealed from all but the engineers, and the superior officers. The supply of water, if from a river, or lake, should be very carefully secured; for this purpose, it is often necessary to enlarge the outworks so as to command sluices, &c. whereby the ditch or reservoirs are filled. If possible, large tanks should be kept in the garrison, or a proper quantity of casks should be filled, especially in parts where wells cannot be dug; lest the besiegers should either drain off the lake, or get command of the sluices, and block them up. If particular parts of the surrounding country can be inundated, it sometimes renders all attempts to carry the place by breaching the walls, utterly impracticable. When this happens, and that the situation admits of its being completely invested (whereby it is meant that all access is cut off) the place may fall in consequence of a blockade. The chances of war are, however, greatly against the success of blockades; for, if the garrison be strong and well provided, it may make numerous successful sallies against an army which must be greatly dispersed by surrounding the place; while the diseases incident to fixed camps, bad provisions, putrid water, constant watching, and probably the necessity of countervallation throughout its rear, to keep off partisans, or to repel such forces as may hover about with the intention to relieve the place, all combine to weaken, dishearten, and cause relaxation among the besiegers. In this instance, the besieged who have but one object, namely, the defence of the works, have some advantage. But a good general will never sit down before a town he is not tolerably certain must fall in a given time.

An ample stock of ready made palisades, chevaux de frises, &c. ought to be made in time of peace, and be safely deposited, so as to be out of the reach of carcases, shells, &c.; lest they should take fire. Such machines are generally best preserved, and are safest, when immersed in water. Fascines, which are large faggots, are dangerous in a fortress, being so soon kindled, and so prompt to get into a great blaze, as to prove highly injurious. When the soil is sandy, or of common loam or gravel, canvas bags should be kept in readiness to be filled, so as to stop a breach, or to raise a breastwork, &c. in case of emergency.

Every endeavour should be exerted towards obstructing the enemy from reconnoiting the form of the works, as well as their disposition before the respective parts, and their defilement. The want of information as to casemated or solid defences, sometimes proves very distressing to the besiegers; who not rarely come suddenly upon works of which they had no previous information; and, eventually, find themselves enfiladed, or at least directly opposed by some masked battery; such as the embrasures in casemated curtains and bastions; or by redoubts within ravelines, of which they had no intelligence, and which could not be discovered from the glacis.

It sometimes occurs, that after getting possession of the works, the besiegers are compelled to quit the body of the place, and to retreat to their lodgments on the counterscarp. This, for the most part, is occasioned by the judicious situation of a citadel; or by the peculiar mode of building the houses, &c. Indeed it has more than once happened, that as the breach was stormed, and perhaps carried, succours have entered at some opposite part of the fortress, and enabled the garrison to take the field with advantage. Sieges are, very frequently, raised by the approach of succours; and many an army, thus retiring, has been either shut up, or compelled to lay down its arms.

The great variety of favourable occurrences occasionally offering in behalf of those brave men, who, regardless of the labours, and of the painful privations to which the besieged are ever subject, continue firm to their duty, should stimulate each individual to the utmost exertion, and to submit to every hardship without a murmur. The example of the governor, and of the officers in general, rarely fails to produce that happy effect; and, as we have so gloriously witnessed, in the case of Gene-

ral Elliott's defence of Gibraltar, creates an enthusiasm that makes each man a hero! It is in such places, and in such exigencies, that the man of genius may render himself conspicuous, and his name immortal! The planning of defences in opposition to approaches, both numerous and stupendous in their construction, and the contrivance of interior safety, as well as the means of protracting, and of annihilating the efforts of a numerous besieging army, composed of the flower of two nations, while they upheld the brave defenders of Gibraltar to the admiration of the world, and endeared them to their country, afford the best example as to the duties of those who are entrusted with the defence of fortified places, and should encourage to the formation of work after work in the interior, to prolong the doubtful contest, and to hold out to the very last moment.

Fortification under such circumstances is certainly a most important science; and, when duly executed, often gives a turn to the balance of war, and produces the most extraordinary reverses. Record furnishes various instances of comparative handfuls of men, having, by the aid of field-works, such as a line of redans or fleches, supported by redoubts, within musquet-shot of each other; or of swallow-tails, that is, irregularly indented lines, and various other defences made in favourable positions; such as rising grounds, or between two deep rivers, or around a town, or among heavy woods, so completely foiled all the attempts of large armies, as to cause their retreat, and ultimately their route or dispersion. Field-works are generally slight, being intended only for temporary defence; they sometimes answer well for the protection of convoys, and are always most formidable when flanked by posts made in churches, mills, old castles, and a variety of such edifices. When the ground is uneven, the line should run so as to occupy the most commanding spots; at which the artillery should be principally stationed.

Field fortification is full of variety; for it is perhaps scarcely possible to point out any two stations taken by any army in the course of many and active campaigns, that would suit the same form of defence. Hence the superior ability of an engineer becomes conspicuous. An inferior army is obliged to intrench on the strongest ground it can command, so as to check a superior, and conquering enemy, advancing rapidly to its attack. No time is left for deep research, for consultation, for substitution, or for the correction of errors: the thing must be done off hand! When such is the case, the engineer must first observe the weak points, and effectually secure them. He must then take every advantage of the strong parts; and, connecting the two, so that the former shall be supported by the latter, form such a powerful range of opposition, as may at once appal the eager assailants. The knowledge of component parts, of fit proportions, and of a thousand technical requisites, are attainable by most persons of common intellect; but many possess a great depth of learning in these particulars, who nevertheless are wanting in the indispensable qualities of quick perception, and of ready and appropriate decision.

FORTIFIED, an appellation given to places defended by ramparts, bastions, ditches, covert-ways, half-moons, ravelines, tenailles, and other out-works. See the preceding article.

FOSS, in fortification, a hollow place, commonly full of water, lying between the scarp and counterscarp, below the rampart; and turning round a fortified place, or a post that is to be defended.

Foss *way*, one of the four principal highways of England, that anciently led through the kingdom; supposed to be made by the Romans, having a ditch upon one side thereof.

FOSSA, in our ancient customs, was used to signify a ditch full of water, wherein women, convicted of felony, were drowned. See FURCA.

FOSSIL, in natural history, denotes, in general, every thing dug out of the earth, whether they be natives thereof, as metals, stones, salts, earths, and other minerals; or extraneous, reposited in the bowels of the earth by some extraordinary means, as earthquakes, the deluge, &c. See MINERALOGY.

FOTHERGILLA, in botany, so called in memory of John Fothergill, M. D. a genus of the Polyandria Digynia class and order. Natural order of Amentaceæ, Jussieu. Essential character: calyx ament, ovate; scales one-flowered; corolla calyxform, one-petalled, five-cleft. There is but one species.

FOTHERING, in naval affairs, a peculiar method of endeavouring to stop a leak in the bottom of a ship, while she is afloat, either at sea or at anchor, which is performed by fastening a sail at the four corners, letting it down under the ship's bottom,

and then putting a quantity of chopped rope-yarns, oakum, wool, &c. between it and the ship's side; by repeating the latter part of this operation several times the leak generally sucks in a portion of the loose stuff, and thereby becomes, in part, or altogether, stopped.

FOUL, or FOULE, in the sea language, is used when a ship has been long untrimmed, so that the grass-weeds, or barnacles grow to her sides under water. A rope is also foul when it is either tangled in itself or hindered by another, so that it cannot run or be over-hawled.

FOUL, imports also the running of one ship against another. This happens sometimes by the violence of the wind, and sometimes by the carelessness of the people on board, to ships in the same convoy, and to ships in port by means of others coming in. The damages occasioned by running foul are of the nature of those in which both parties must bear a part. They are usually made half to fall upon the sufferer, and half upon the vessel which did the injury: but in cases where it is evidently the fault of the master of the vessel, he alone is to bear the damage.

FOUL *water*. A ship is said to make foul water when being under sail, she comes into such shoal water, that though her keel does not touch the ground, yet it comes so near it that the motion of the water under her raises the mud from the bottom.

FOUNDATION, in architecture, is that part of a building which is under ground. See ARCHITECTURE and BUILDING.

FOUNDATION, denotes also a donation or legacy, either in money or lands, for the maintenance and support of some community, hospital, school, lecture, &c.

FOUNDER, in a general sense, the person who lays a foundation, or endows a church, school, religious house, or other charitable institution. The founder of a church may preserve to himself the right of patronage, or presentation to the living.

FOUNDER, also implies an artist who casts metals in various forms, for different uses, as guns, bells, statues, printing characters, candlesticks, buckles, &c. whence they are denominated gun-founders, bell-founders, figure-founders, letter-founders, founders of small works, &c. See FOUNDERY.

FOUNDER, in the sea language. A ship is said to founder when by an extraordinary leak, or by a great sea breaking in upon her, she is so filled with water that she cannot be freed of it; so that she can neither veer nor steer, but lie like a log; and not being able to swim along will at last sink.

FOUNDERY, or FOUNDRY, the art of casting all sorts of metals into different forms. It likewise signifies the work-house, or smelting-hut, wherein these operations are performed. See IRON FOUNDERY.

FOUNDERY *of small-works, or casting in sand*. The sand used for casting small-works is, at first, of a pretty soft, yellowish, and clammy nature: but it being necessary to strew charcoal dust in the mould, it at length becomes of a quite black colour. This sand is worked over and over, on a board, with a roller and a sort of knife; being placed over a trough to receive it, after it is by these means sufficiently prepared.

This done they take a wooden board, of a length and breadth proportional to the things to be cast, and putting a ledge round it they fill it with sand, a little moistened, to make it duly cohere. Then they take either wood or metal models of what they intend to cast, and apply them so to the mould, and press them into the sand, as to leave their impression there. Along the middle of the mould is laid half a small brass cylinder, as the chief canal for the metal to run through, when melted, into the models, or patterns; and from this chief canal are placed several others which extend to each model or pattern placed in the frame. After this frame is finished they take out the patterns, by first loosening them all round, that the sand may not give way.

Then they proceed to work the other half of the mould with the same patterns in just such another frame, only that it has pins, which, entering into holes that correspond to it in the other, make the two cavities of the pattern fall exactly on each other.

The frame thus moulded is carried to the melter, who, after extending the chief canal of the counterpart, and adding the cross canals to the several models in both, and strewing mill dust over them, dries them in a kind of oven for that purpose.

Both parts of the mould being dry, they are joined together by means of the pins; and to prevent their giving way, by reason of the melted metal passing through the chief cylindrical canal, they are screwed or wedged up like a kind of a press.

While the moulds are thus preparing the metal is fusing in a crucible, of a size pro-

portionate to the quantity of metal intended to be cast.

Some of these small-work founder's furnaces are like a smith's forge, others stand a few feet under ground, for the more easily and safely taking out a weighty pot of metal; which is done by means of a circular tongs that grasps round the top of the crucible. When the metal is melted the workman pours it through the chief canal of each mould, which conveys it to every distinct pattern.

When the moulds are cool the frames are unscrewed, or unwedged, and the cast-work taken out of the sand, which sand is worked over again for other castings.

FOUNDERY *of statues.* The casting of statues depends on the due preparation of the pit, the core, the wax, the outer mould, the inferior furnace to melt off the wax, and the upper to fuse the metal. The pit is a hole dug in a dry place something deeper than the intended figure, and made according to the prominence of certain parts thereof. The inside of the pit is commonly lined with stone, or brick; or, when the figure is very large, they sometimes work on the ground, and raise a proper fence to resist the impulsion of the melted metal.

The inner mould, or core, is a rude mass, to which is given the intended attitude and contours. It is raised on an iron-grate, strong enough to sustain it, and is strengthened within by several bars of iron. It is generally made either of potter's clay, mixed with hair and horse-dung, or of plaster of Paris mixed with brick-dust. The use of the core is to support the wax, the shell, and lessen the weight of the metal. The iron bars and the core are taken out of the brass figure through an aperture left in it for that purpose, which is soldered up afterwards. It is necessary to leave some of the iron bars of the core that contribute to the steadiness of the projecting part within the brass figure.

The wax is a representation of the intended statue. If it be a piece of sculpture, the wax should be all of the sculptor's own hand, who usually forms it on the core; though it may be wrought separately, in cavities, moulded on a model, and afterwards arranged on the ribs of iron over the grate; filling the vacant space in the middle with liquid plaster and brick-dust, whereby the inner core is proportioned as the sculptor carries on the wax.

When the wax, which is the intended thickness of the metal, is finished, they fill small waxen tubes perpendicular to it from top to bottom, to serve both as canals for the conveyance of the metal to all parts of the work, and as vent-holes to give passage to the air, which would otherwise occasion great disorder when the hot metal came to encompass it.

The work being brought thus far must be covered with its shell, which is a kind of crust laid over the wax, and which being of a soft matter easily receives the impression of every part, which is afterwards communicated to the metal upon its taking the place of the wax, between the shell and the mould. The matter of this outer mould is varied according as different layers are applied. The first is generally a composition of clay and old white crucibles well ground and sifted, and mixed up with water to the consistence of a colour fit for painting: accordingly they apply it with a pencil, laying it seven or eight times over, and letting it dry between whiles. For the second impression they add horse-dung and natural earth to the former composition. The third impression is only horse-dung and earth. Lastly, the shell is finished by laying on several more impressions of this last matter, made very thick with the hand.

The shell thus finished is secured by several iron girts bound round it, at about half a foot distance from each other, and fastened at the bottom to the grate under the statue, and at top to a circle of iron where they all terminate.

If the statue be so big that it would not be easy to move the moulds with safety, they must be wrought on the spot where it is to be cast. This is performed two ways: in the first a square hole is dug under ground, much bigger than the mould to be made therein, and its inside lined with walls of free-stone or brick. At the bottom is made a hole of the same materials with a kind of furnace, having its aperture outwards: in this is a fire made to dry the mould, and afterwards melt the wax. Over this furnace is placed the grate, and upon this the mould, &c. formed as above. Lastly, at one of the edges of the square pit is made another large furnace to melt the metal. In the other way it is sufficient to work the mould above ground, but with the like precaution of a furnace and grate underneath. When finished, four walls are to be run around it, and by the side thereof a massive made for a melting-furnace. For the rest, the method is the same in

both. The mould being finished, and inclosed as described, whether under ground or above it, a moderate fire is lighted in the furnace under it, and the whole covered with planks, that the wax may melt gently down, and run out at pipes contrived for that purpose, at the foot of the mould, which are afterwards exactly closed with earth, so soon as the wax is carried off. This done, the hole is filled up with bricks thrown in at random, and the fire in the furnace augmented, till such time as both the bricks and mould become red hot. After this, the fire being extinguished and every thing cold again, they take out the bricks and fill up their place with earth, moistened and a little beaten, to the top of the mould, in order to make it the more firm and steady. These preparatory measures being duly taken, there remains nothing but to melt the metal, and run it into the mould. This is the office of the furnace above described, which is commonly made in the form of an oven with three apertures, one to put in the wood, another for a vent, and a third to run the metal out at. From this last aperture, which is kept very close while the metal is in fusion, a small tube is laid, whereby the melted metal is conveyed into a large earthen bason over the mould, into the bottom of which all the big branches of the jets or casts, which are to convey the metal into all the parts of the mould, are inserted.

These casts or jets are all terminated with a kind of plugs, which are kept close, that upon opening the furnace the brass, which gushes out with violence, may not enter any of them, till the bason be full enough of matter to run into them all at once. Upon which occasion they pull out the plugs, which are long iron rods with a head at one end capable of filling the whole diameter of each tube. The whole of the furnace is opened with a long piece of iron fitted at the end of each pole, and the mould filled in an instant. This completes the work in relation to the casting part; the rest being the sculptor's or carver's business, who, taking the figure out of the mould and earth wherewith it is encompassed, saws off the jets with which it appears covered over, and repairs it with chissels, gravers, puncheons, &c.

Foundery *of bells*. The metal for bells has already been described. See Bell.

The dimensions of the core, and the wax, for bells, if a ring of bells especially, are not left to chance, but must be measured on a scale, or diapason, which gives the height, aperture, and thickness necessary for the several tones required. It is on the wax that the several mouldings and other ornaments are formed to be represented in relievo on the outside of the bell.

The business of bell-foundery is reducible to three particulars: the proportion of a bell; the forming of the mould; and, the melting of the metal.

The proportions of our bells differ much from those of the Chinese: in ours the modern proportions are to make the diameter fifteen times the thickness of the brim, and twelve times the height.

There are two kinds of preparations, *viz.* the simple and the relative: the former are those proportions only that are between the several parts of a bell, to render it sonorous; the relative proportions establish a requisite harmony between several bells.

The particulars necessary for making the mould of a bell, are, 1. The earth; the most cohesive is the best: it must be well ground and sifted, to prevent any chinks. 2. Brick-stone; which must be used for the mine, mould, or core, and for the furnace. 3. Horse-dung, hair, and hemp, mixed with the earth, to render the cement more binding. 4. The wax for inscriptions, coats of arms, &c. 5. The tallow equally mixed with the wax, in order to put a slight lay of it upon the outer mould, before any letters are applied to it. 6. The coals to dry the mould.

For making the mould, they have a scaffold consisting of four boards, ranged upon tressels. Upon this they carry the earth, grossly diluted, to mix it with horse-dung, beating the whole with a large spatula.

The compasses of construction is the chief instrument for making the mould, which consist of two different legs, joined by a third piece. And last of all, the founder's shelves, on which are the engravings of the letters, cartridges, coats of arms, &c.

They first dig a hole of a sufficient depth to contain the mould of the bell, together with the case, or cannon, under ground; and about six inches lower than the terrepleine, where the work is performed. The hole must be wide enough for a free passage between the mould and walls of the hole; or between one mould and another, when several bells are to be cast. At the centre of the hole is a stake erected, that is strongly fastened in the ground. This supports an iron peg, on which the pivot of the second branch of the compasses turns. The stake is encompassed with a solid brick-work, perfectly round, about half a foot high, and

of the proposed bell's diameter. This they call a mill-stone. The parts of the mould are the core, the model of the bell, and the shell. When the outer surface of the core is formed, they begin to raise the core, which is made of bricks that are laid in courses of equal height upon a lay of plain earth. At the laying each brick they bring near it the branch of the compasses, on which the curve of the core is shaped, so as that there may remain between it and the curve the distance of a line, to be afterwards filled up with layers of cement. The work is continued to the top, only leaving an opening for the coals to bake the core. This work is covered with a layer of cement, made of earth and horse-dung, on which they move the compasses of construction, to make it of an even smoothness every where.

The first layer being finished, they put the fire to the core, by filling it half with coals, through an opening that is kept shut, during the baking, with a cake of earth, that has been separately baked. The first fire consumes the stake, and the fire is left in the core half, or sometimes a whole day: the first layer being thoroughly dry, they cover it with a second, third, and fourth; each being smoothed by the board of the compasses, and thoroughly dried before they proceed to another.

The core being completed, they take the compasses to pieces, with intent to cut off the thickness of the model, and the compasses are immediately put in their place, to begin a second piece of the mould. It consists of a mixture of earth and hair, applied with the hand on the core, in several cakes that close together. This work is finished by several layers of a thinner cement of the same matter, smoothed by the compasses, and thoroughly dried, before another is laid on. The first layer of the model is a mixture of wax and grease spread over the whole. After which are applied the inscriptions, coats of arms, &c. besmeared with a pencil dipped in a vessel of wax in a chafing-dish: this is done for every letter. Before the shell is begun, the compasses are taken to pieces, to cut off all the wood that fills the place of the thickness to be given to the shell.

The first layer is the same earth with the rest, sifted very fine; whilst it is tempering in water, it is mixed with cow's hair, to make it cohere. The whole being a thin cullis, is gently poured on the model, that fills exactly all the sinuosities of the figures, &c. and this is repeated till the whole is two lines thick over the model. When this layer is thoroughly dried, they cover it with a second of the same matter, but something thicker: when this second layer becomes of some consistence, they apply the compasses again, and light a fire in the core, so as to melt off the wax of the inscriptions, &c.

After this, they go on with other layers of the shell, by means of the compasses. Here they add to the cow's hair a quantity of hemp, spread upon the layers, and afterwards smoothed by the board of the compasses. The thickness of the shell comes to four or five inches lower than the mill-stone before observed, and surrounds it quite close, which prevents the extravasation of the metal. The wax should be taken out before the melting of the metal.

The ear of the bell requires a separate work, which is done during the drying of the several incrustations of the cement. It has seven rings; the seventh is called the bridge, and unites the others, being a perpendicular support to strengthen the curves. It has an aperture at the top, to admit a large iron peg, bent at the bottom; and this is introduced into two holes in the beam, fastened with two strong iron keys. There are models made of the rings, with masses of beaten earth, that are dried in the fire, in order to have the hollow of them. These rings are gently pressed upon a layer of earth and cow's hair, one half of its depth; and then taken out, without breaking the mould. This operation is repeated twelve times for twelve half-moulds, that two and two united may make the hollows of the six rings: the same they do for the hollow of the bridge, and bake them all, to unite them together.

Upon the open place left for the coals to be put in, are placed the rings that constitute the ear. They first put into this open place the iron ring to support the clapper of the bell; then they make a round cake of clay, to fill up the diameter of the thickness of the core. This cake, after baking, is clapped upon the opening, and soldered with a thin mortar spread over it, which binds the cover close to the core.

The hollow of the model is filled with an earth sufficiently moist to fix on the place, which is strewed at several times upon the cover of the core; and they beat it gently with a pestle, to a proper height; and a workman smooths the earth at top with a wooden trowel dipped in water.

Upon this cover, to be taken off after-

wards, they assemble the hollows of the rings. When every thing is in its proper place, they strengthen the outsides of the hollows with mortar, in order to bind them with the bridge, and keep them steady at the bottom, by means of a cake of the same mortar, which fills up the whole aperture of the shell. This they let dry, that it may be removed without breaking. To make room for the metal they pull off the hollows of the rings, through which the metal is to pass, before it enters into the vacuity of the mould. The shell being unloaded of its ear, they range under the mill-stone five or six pieces of wood, about two feet long, and thick enough to reach almost the lower part of the shell; between these and the mould they drive in wooden wedges with a mallet, to shake the shell of the model whereon it rests, so as to be pulled up, and got out of the pit.

When this and the wax are removed, they break the model and the layer of earth, through which the metal must run, from the hollow of the rings, between the bell and the core. They smoke the inside of the shell, by burning straw under it, that helps to smooth the surface of the bell. Then they put the shell in the place, so as to leave the same interval between that and the core; and before the hollows of the rings or the cap are put on again, they add two vents, that are united to the rings, and to each other, by a mass of baked cement. After which they put on this mass of the cap, the rings, and the vent, over the shell, and solder it with thin cement, which is dried gradually, by covering it with burning coals. Then they fill up the pit with earth, beating it strongly all the time, round the mould.

The furnace has a place for the fire, and another for the metal. The fire-place has a large chimney, with a spacious ash-hole. The furnace, which contains the metal, is vaulted, whose bottom is made of earth, rammed down; the rest is built with brick. It has four apertures; the first, through which the flame reverberates; the second is closed with a stopple that is opened for the metal to run; the others are to separate the dross, or scoriæ, of the metal by wooden rakes: through these last apertures passes the thick smoke. The ground of the furnace is built sloping, for the metal to run down.

Foundery *of great guns and mortar-pieces.* The method of casting these pieces is little different from that of bells: they are run massy, without any core, being determined by the hollow of the shell; and they are afterwards bored with a steel trepan, that is worked either by horses or a water-mill or steam.

Foundery, *Letter*, or *casting of printing types.* The first thing requisite is to prepare good steel punches, on the face of which is drawn the exact shape of the letter with pen and ink, if the letter be large; or with a smooth blunted point of a needle, if small; and then, with proper gravers, the cutter digs deep between the strokes, letting the marks stand on the punch; the work of hollowing being generally regulated by the depth of the counter punch: then he files the outside, till it is fit for the matrice.

They have a mould to justify the matrices by, which consists of an upper and under part, both these are alike, except the stool and spring behind, and a small roundish wire in the upper part, for making the nick in the shank of the letter. These two parts are exactly fitted into each other, being a male and female gage, to slide backwards and forwards.

Then they justify the mould, by casting about twenty samples of letters, which are set in a composing-stick, with the nicks towards the right hand; and comparing these every way with the pattern-letters, set up in the same manner, they find the exact measure of the body to be cast.

Next they prepare the matrice, which is of brass or copper, an inch and a half long, and of a proportionable thickness to the size of the letter it is to contain. In this metal is sunk the face of the letter, by striking the letter-punch the depth of an *n*. After this, the sides and face of the matrice are justified, and cleared, with files, of all bunchings that have been made by sinking the punch.

Then it is brought to the furnace, which is built upright of brick with four square sides and a stone at top, in which is a hole for the pan to stand in. They have several of these furnaces.

Printing-letters are made of lead, hardened with iron or stub-nails. To make the iron run, they mingle an equal weight of antimony, beaten small in an iron mortar, and stub-nails together. They charge a proper number of earthen pots, that bear the fire, with the two ingredients, as full as they can hold, and melt it in an open furnace, built for that purpose. When it bubbles, the iron is then melted, but it evaporates very much. This melted compost is

ladled into an iron pot, wherein is melted lead, that is fixed on a furnace close to the former, *3lb.* of melted iron to *25lb.* of lead; this they incorporate according to art.

The caster taking the pan off the stone, and having kindled a good fire, he sets the pan in again, and metal in it to melt. If it be a small-bodied letter, or a thin letter with great bodies, that he intends to cast, his metal must be very hot, and sometimes red-hot, to make the letter come. Then taking a ladle, of which he has several sorts, that will hold as much as will make the letter and break, he lays it at the hole where the flame bursts out; then he ties a thin leather, cut with its narrow end against the face, to the leather groove of the matrice, by whipping a brown thread twice about the leather groove, and fastening the thread with a knot. Then he puts both pieces of the mould together, and the matrice into the matrice-cheek; and places the foot of the matrice on the stool of the mould, and the broad end of the leather on the wood of the upper haft of the mould, but not tight up, lest it hinder the foot of the matrice from sinking close down upon the stool, in a train of work. Afterwards laying a little resin on the upper part of the mould, and having his casting-ladle hot, he, with the bolling side, melts the resin and presses the broad end of the leather hard down on the wood, and so fastens it thereto. Now he comes to casting, when placing the under half of the mould in his left hand, with the hook or jag forward, he holds the ends of its wood between the lower part of the ball of his thumb and his three hinder fingers; then he lays the upper half of the mould upon the under half, so as the male gages may fall into the female; and, at the same time, the foot of the matrice places itself upon the stool, and clasping his left hand thumb strongly over the upper half, he nimbly catches hold of the bow or spring, with his right hand fingers at the top of it, and his thumb under it, and places the point of it against the middle of the notch in the backside of the matrice, pressing it forwards, as well towards the mould as downwards, by the shoulder of the notch, close upon the stool, while at the same time, with his hinder fingers, as aforesaid, he draws the under half of the mould towards the ball of his thumb, and thrusts, by the ball of his thumb, the upper part towards his fingers, that both the registers of the mould may press against both sides of the matrice, and his thumb and fingers press both sides of the mould close together.

Then he takes the handle of his ladle in his right hand, and with the ball of it gives two or three strokes outwards upon the surface of the melted metal, to clear it of the scum; then he takes up the ladle full, and having the mould in the left hand, turns his left side a little from the furnace, and brings the geat of his ladle to the mouth of the mould; and turns the upper part of his right hand towards him, to pour the metal into it, while, at the same instant, he puts the mould in his left hand forwards, to receive the metal with a strong shake, not only into the bodies of the mould, but, while the metal is yet hot, into the very face of the matrice, to receive its perfect form there as well as in the shank. Then he takes the upper half of the mould off, by placing his right thumb on the end of the wood next his left thumb, and his two middle fingers at the other end of the wood: he tosses the letter, break and all, out upon a sheet of waste paper, laid on a bench a little beyond his left hand; and then is ready to cast another letter as before, and likewise the whole number in that matrice.

Then boys, commonly employed for this purpose, separate the breaks from the shanks, and rub them on a stone, and afterwards a man cuts them all of an even height, which finishes the fount for the use of the printer. See the next article. A workman will ordinarily cast 3000 of these letters in a day. The perfection of letters thus cast, consists in their being all severally square and straight on every side; and all generally of the same height, and evenly lined, without stooping one way or other; neither too big in the foot nor the head; well grooved, so as the two extremes of the foot contain half the body of the letter; and well ground, barbed, and scraped, with a sensible notch, &c. See Printing.

FOUNT, or Font, among printers, a set or quantity of letters, and all the appendages belonging thereto, as numeral characters, quadrates, points, &c. cast by a letter-founder, and sorted. Founts are large or small, according to the demand of the printer, who orders them by the hundred weight, or by sheets. When a printer orders a fount of five hundred, he means that the fount, consisting of letters, points, spaces, quadrates, &c. shall weigh *500lb.* When he demands a fount of ten sheets, it is understood, that with that fount he shall

be able to compose ten sheets, or twenty forms, without being obliged to distribute. The founder takes his measures accordingly; he reckons 120*lb.* for a sheet, including the quadrates, &c. or 60*lb.* for a form, which is only half a sheet: not that the sheet always weighs 120*lb.*, or the form 60*lb.*; on the contrary, it varies according to the size of the form; besides, it is always supposed that there are letters left in the cases. As, therefore, every sheet does not comprehend the same number of letters, nor the same sort of letters, we must observe, that, as in every language some sounds recur more frequently than others, some letters will be in much more use, and oftener repeated than others, and consequently their cells or cases should be better stored than those of the letters which do not recur so frequently: thus, a fount does not contain an equal number of *a* and *b*, or of *b* and *c*, &c. the letter-founders have therefore a list or tariff, or, as the French call it, a police, by which they regulate the proportions between the different sorts of characters that compose a fount; and it is evident that this tariff will vary in different languages, but will remain the same for all sorts of characters employed in the same language. Suppose a fount of 100,000 characters, which is a common fount, here *a* should have 5,000; *c*, 3,000; *e*, 11,000; *i*, 6,000; *m*, 3,000; the *k*, only 30; and the *x*, *y*, and *z* not many more.

FOUNTAIN, in philosophy, a spring or source of water, rising out of the earth. Among the ancients, fountains were held sacred, and even worshipped as a kind of divinities. For the phænomena, theory, and origin of fountains or springs, see SPRING.

FOUNTAIN, or *Artificial Fountain*, in hydraulics, called also a *jet d'eau*, is a contrivance by which water is violently spouted upwards. See HYDRAULICS.

FOUNTAIN *pen*. See PEN.

FOURTH, in music, one of the harmonical intervals, called concords. It is called fourth, as containing four sounds or terms between its extremes, and three intervals; or, as being the fourth in order of the natural or diatonic scale, from the fundamental. The ancients called it diatessaron, and speak of it as the principal concord, on whose divisions all the rest depend; but the moderns, so far from allowing it such perfections, find it one of the most imperfect, and even dispute whether it ought to be received among the number of concords at all. It consists in the mixture of two sounds in the ratio of 4 : 3; that is, of two sounds produced by two chords, whose lengths, &c. are in that proportion.

FOWLING, the art of taking or killing birds. It is either practised as an amusement by persons of rank and property, and then principally consists in killing them with a light fire-arm, called a fowling-piece, and the diversion is secured to them by the game-laws; or it is practised for a livelihood, by persons who use nets and other apparatus. Though there is much skill and knowledge displayed in fowling with the fowling-piece, not only in the use of the instrument, but likewise in the training of dogs, and discovering and starting the game, we must, from the nature of our limits, avoid entering into this subject. The other artifices by which birds are taken, consist in imitating their voices, or leading them, by other means, into situations where they become entrapped by nets, or birdlime, or otherwise.

The pipe, or call, affords the most common means used, to take great numbers of birds; this is done in the months of September and October. A thin wood is the spot chosen for this purpose; under a tree a little distant from the others, is erected a cabin, and there are only those branches left on the tree, which are necessary for the placing of the birdlime, which are supple twigs, and are covered with birdlime. There are placed around the cabin avenues with twisted perches, which are also besmeared with birdlime. The birdcatcher places himself in the cabin, and at sun-rise and sun-set, imitates the cry of a small bird, calling the others to its assistance; for animals have also their cries to express their different passions, which are well known to each other. If a cry is made to imitate the owl, immediately different sorts of birds assemble at the cry of their common enemy, and they are seen falling to the ground at every instant, their wings, from the birdlime, being of no use to them. The cries of those birds which are thus caught attract others, and great quantities are in this manner taken. It is only during the night that the great and small owls are taken, by counterfeiting the cry of the mouse.

To take the lark, nets are spread, and about the middle of the net is placed a looking-glass, to which a cord is attached,

which, upon being drawn, makes the glass turn round like the sails of a windmill; during the time that the sun shines, it is put in motion, its brilliancy attracts the larks, whose feet get entangled in the meshes of the nets. The clap-net is also made use of during the night; this is a large slender net, which is supported at each end by two men upon long poles; they walk about the ground until they hear the larks, when they let it fall, and take by this means vast quantities.

Water-fowl may be taken in great numbers, by nets properly managed. The net for this purpose should be always made of the smallest and strongest packthread that can be got. The meshes may be large, but the nets should be lined on both sides with other smaller nets, every mesh of which is to be about an inch and a half square, each way, that as the fowls strike either through them or against them, the smaller may pass through the great meshes, and so streighten and entangle the fowl.

These nets are to be pitched for every evening-flight of fowl, about an hour before sunset, staking them on each side of the river, about half a foot within the water, the lower side of the net being so plummed, that it may sink so far, and no farther; place the upper side of the net slantwise, shoaling against the water, but not touching it by nearly two feet; and let the strings which support this upper side of the net, be fastened to small yielding sticks set in the bank; these, as the fowl strikes, will give the net liberty to play, and to entangle them. Several of these nets should be placed at once over different parts of the river, at about twelve-score fathom distance one from another; and if any fowl come that way, the sportsman will have a share of them. It is a good method, when the nets are set, to go to places sufficiently distant from them with a gun, to frighten them toward the places where the nets are; and wherever any of the fowl are started from, it may not be amiss to plant some nets also there, to take them as they return. The nets are to be left thus placed all night, and in the morning, the sportsman is to go and see what is caught; he should visit the river first, and take up what are caught there; and, frightening the rest away to the other places where his nets are, he is next to visit them, and take what are there secured.

The Ceylonese have great plenty of water-fowl wild on their island, and have a very remarkable way of catching them, which is this: the fowler enters a lake or other water, which has a good bottom, and is not very deep; he puts an earthern pot upon his head, in which there are bored holes, through which he can see; he keeps himself so bent down in the water, that only the pot is above the surface; in this manner he enters the place where the wild-fowl are in clusters, and they think it is only some floating block. He then takes some one by the legs, and gently draws it under water, and wrings its neck till he has killed it; then putting it into his bag, which is fastened about his middle, he takes hold of another in the same manner, and so on, till he has got as many as he can carry off, and then he goes back in the same manner in which he came, not disturbing the rest of the birds, who never miss their companions, as they seem to dive down for their diversion, when the fowler pulls them under. In places where this has been practised so long, or so carelessly, that the birds are shy, the fowler uses a gun; but this he does in the following manner: he makes a screen of about five feet high, and three feet wide, which he carries in one hand straight between himself and his game, and in the other hand his gun. The birds are not alarmed at what appears only a bush; for this screen is always covered with branches of trees, fresh cut down, and full of leaves, so that the sportsman behind advances as near as he pleases, and then putting the gun through some crevice of the screen, he fires. See DECOY.

FOWLING, was formerly used for the pursuing and taking birds with hawks, more properly called falconry.

FOWLING *piece*, a light gun for shooting birds. That piece is always reckoned best which has the longest barrel, from $5\frac{1}{2}$ to 6 feet, with a moderate bore; though every fowler should have them of different sizes, suitable to the game he designs to kill. The barrel should be well polished and smooth within, and the bore of an equal bigness from one end to the other; which may be proved by putting in a piece of pasteboard, cut of the exact roundness of the top; for if this goes down without stops or slipping, you may conclude the bore good. The bridge-pan must be somewhat above the touch-hole, and ought to have a notch to let down a little powder; this will prevent the piece from recoiling, which it would otherwise be apt to do. As to the locks, choose such as are well filed with true work, whose

springs must be neither too strong nor too weak. The hammer ought to be well hardened, and pliable, to go down to the pan with a quick motion.

In shooting, observe to do it, if possible, with the wind, not against it; and rather sideways, or behind the fowl, than full in their faces. Observe also to choose the most convenient shelter you can find, as a hedge, bank, tree, or the like. Take care to have your dogs under good command, that they may not dare to stir till you give the word, after discharging your piece: for some ill-taught dogs will, upon only the snap of the cock, presently rush forward, and spoil your sport. If you have not shelter enough, you must creep upon your hands, and knees.

FOX, in zoology, an animal of the dog-kind, which much resembles the common dog in form, and is of the size of a spaniel: it is chiefly distinguished by its long and straight tail, with the tip white. See CANIS.

Fox *glove*, in botany. See DIGITALIS.

FRACTION, in arithmetic and algebra, is a part or parts of something considered as an unit or integer. Fractions are distinguished into vulgar or common, and sexagesimal and decimal. See SEXAGESIMALS and DECIMAL.

Vulgar fractions, called also simply fractions, consist of two parts or quantities; one wrote over the other, with a line between them. The quantity placed above the line is called the numerator of the fraction; and the quantity placed under the line, the denominator.

Thus, $\frac{2}{3}$ expresses the quotient of 2, divided by 3, and 2 is the numerator, and 3 the denominator. If the numerator of a fraction is equal to its denominator, then the fraction is equal to unity: thus $\frac{4}{4}=1$, and $\frac{a}{a}$ or $\frac{b}{b}$ are likewise equal to unity. If the numerator is greater than the denominator, then the fraction is greater than unit. In both these cases, the fraction is called improper; but if the numerator is less than the denominator, then the fraction is less than unit, and is called proper: thus $\frac{5}{3}$ is an improper fraction, but $\frac{3}{4}$ or $\frac{2}{3}$ are proper fractions. A mixed quantity is that whereof one part is an integer, and the other a fraction; as $3\frac{4}{5}$, $5\frac{2}{3}$, and $a+\frac{a^2}{b}$. See ALGEBRA.

FRACTURE, in surgery, a rupture of a bone, or a solution of continuity in a bone, when it is crushed or broken by some external cause. See SURGERY.

FRÆNUM, in anatomy, a term applied to some membranous ligaments of the body.

FRÆNUM *linguæ*, the ligament under the tongue, which sometimes ties it down too close to the bottom of the mouth; and then requires to be incised or divided, in order to give this organ its proper and free motion.

FRAGARIA, in botany, English *strawberry*, a genus of the Icosandria Polygynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx ten-cleft; petals five; receptacle of the seeds ovate, and like a berry. There are three species, and many varieties.

FRAIL, a basket made of rushes, or the like, in which are packed up figs, raisins, &c. It signifies also a certain quantity of raisins, about 75 pounds.

FRAISE, in fortification, a kind of defence, consisting of pointed stakes, six or seven feet long, driven parallel to the horizon into the retrenchments of a camp, a half-moon, or the like, to prevent any approach or scalade.

Fraises differ from palisades chiefly in this, that the latter stand perpendicular to the horizon, and the former jet out parallel to the horizon, or nearly so, being usually made a little sloping, or with the points hanging down. Fraises are chiefly used in retrenchments and other works thrown up of earth; sometimes they are found under the parapet of a rampart, serving instead of the cordon of stone used in stone-works.

FRANK, or FRANC, meaning literally free from charges and impositions, or exempt from public taxes, has various significations in our ancient customs.

FRANK, or FRANC, an ancient coin, either of gold or silver, struck and current in France. The value of the gold frank was somewhat more than that of the gold crown; the silver frank was a third of the gold one: this coin is long out of use, though the term is still retained as the name of a money of account; in which sense it is equivalent to the livre, or twenty sols.

FRANKENIA, in botany, so named in honour of John Frankenius, professor of botany at Upsala, a genus of the Hexandria Monogynia class and order. Natural order of Calycanthemæ. Caryophylle, Jussieu. Essential character: calyx five-cleft,

funnel-form; petals five; stigma six-parted; capsule one-celled, three-valved. There are three species.

FRANKFORT *black*, is the chief ingredient in the copper-plate printer's ink; it is made of the lees of wine, burnt, washed in water, and ground in mills, together with ivory, or the stones from peaches and other fruit. The best is that made at Frankfort on the Mayn, though a great deal is made at Mentz, Strasburg, and different parts of France.

FRANKINCENSE, is a gummy resin, the product of the juniperus lycia, consisting of equal parts of gum and resin; the first is soluble in water, the other in alcohol. It is brought from Turkey and the East Indies, but is principally collected in Arabia. It usually comes to us in drops, but in a very impure state, a hundred pounds not yielding more than from forty to fifty pounds of pure frankincense.

FRANKLIN (Dr. Benjamin), in biography, one of the most celebrated philosophers and politicians of the eighteenth century, was born in Boston, in North America, in the year 1706, being the youngest of thirteen children. His father was a tallow-chandler in Boston, and young Franklin was taken away from school at ten years of age, to assist him in his business. In this situation he continued two years, but disliking this occupation, he was bound apprentice to an elder brother, who was then a printer in Boston, but had learned that business in London, and who, in the year 1721, began to print a newspaper, being the second ever published in America; the copies of which our author was sent to distribute after having assisted in composing and printing it. Upon this occasion our young philosopher enjoyed the secret and singular pleasure of being the much-admired author of many essays in this paper, a circumstance which he had the address to keep a secret even from his brother himself, and this when he was only fifteen years of age. The frequent ill usage from his brother induced young Franklin to quit his service, which he did at the age of seventeen, and went to New York; but not meeting employment here, he went forward to Philadelphia, where he worked with a printer a short time; after which, at the instance of Sir William Keith, governor of the province, he returned to Boston to solicit pecuniary assistance from his father to set up a printing-house for himself at Philadelphia, upon the promise of great encouragement from Sir William, &c. His father thought fit, however, to refuse such aid, alleging that he was yet too young (eighteen years old) to be entrusted with such a concern, and our author again returned to Philadelphia without it. Upon this Sir William said he would advance the sum himself, and our young philosopher should go to England and purchase all the types and materials himself, for which purpose he would give him letters of credit. He could never, however, get these letters, yet, by dint of fair promises of their being sent on board the ship after him, he sailed for England, expecting these letters of credit were in the governor's packet, which he was to receive upon its being opened. In this he was cruelly deceived, and thus he was sent to London without money, friends, or credit, at the age of eighteen.

He soon found employment, however, as a journeyman printer, first at Mr. Palmer's, and afterwards with Mr. Watts, with whom he worked a considerable time, and by whom he was greatly esteemed, being also treated with such kindness that it was always most gratefully remembered by our philosopher.

After a stay of eighteen months in London, he returned to Philadelphia, *viz.* in 1726, along with a merchant of that town, as his clerk, on a salary of fifty pounds a year. But his master dying a year after, he again engaged to direct the printing business of the same person with whom he had worked before. After continuing with him the best part of a year, our philosopher, in partnership with another young man, at length set up a printing-house himself.

Before this time young Franklin had gradually associated a number of persons like himself, of a rational and philosophical turn of mind, and formed them into a club or society, to hold meetings to converse and communicate their sentiments together for their mutual improvement in all kinds of useful knowledge, which was in much repute for many years afterwards. Among many other useful regulations, they agreed to bring such books as they had into one place, to form a common library. This resource being found defective, at Franklin's persuasion, they resolved to contribute a small sum monthly towards the purchase of books for their use from London. Thus their stock began to increase rapidly, and the inhabitants of Philadelphia, being desirous of having a share in their literary

knowledge, proposed that the books should be lent out for paying a small sum for the indulgence. Thus, in a few years, the society became rich, and possessed more books than were, perhaps, to be found in all the other colonies. The collection was advanced into a public library, and the other colonies, sensible of its advantage, began to form similar plans, from whence originated the libraries at Boston, New York, Charlestown, &c.; that of Philadelphia being now scarcely inferior to any in Europe.

About 1728, or 1729, young Franklin set up a newspaper, the second in Philadelphia, which proved very profitable, and otherwise useful, as affording an opportunity of making himself known as a political writer, by inserting several of his writings of that kind into it. In addition to his printing-house, he set up a shop to sell books and stationary, and in 1730 he married his wife, who proved very useful in assisting to manage the shop, &c. He afterwards began to have some leisure, both for reading books and writing them, of which he gave many specimens from time to time. In 1732 he began to publish Poor Richard's Almanack, which was continued for many years. It was always remarkable for the numerous and valuable concise maxims it contained for the economy of human life, all tending to exhort to industry and frugality; and, in the almanack for the last year, all the maxims were collected in an address to the reader, entitled the Way to Wealth. This has been translated into various languages, and inserted in various publications. It has also been printed on a large sheet, proper to be framed and hung up in conspicuous places in all houses, as it very well deserves to be. Mr. Franklin became gradually more known for his political talents, and in the year 1736, he was appointed clerk to the general assembly at Pennsylvania, and was re-elected by succeeding assemblies for several years, till he was chosen representative for the city of Philadelphia; and in 1737 he was appointed post-master to that city. In 1738 he formed the first fire company there, to extinguish and prevent fires and the burning of houses; an example which was soon followed by other persons and other places. And soon after he suggested the plan for an association for insuring houses and ships from losses by fire, which was adopted, and the association continues to this day. In the year 1744, during a war between France and Great Britain, some French and Indians made inroads upon the frontier inhabitants of the province, who were unprovided for such an attack; the situation of the province was at that time truly alarming, being destitute of every means of defence. At this crisis Franklin stepped forth, and proposed to a meeting of the citizens of Philadelphia, a plan of a voluntary association for the defence of the province. —This was approved of, and signed by 1200 persons immediately. Copies of it were circulated through the province, and in a short time the number of signatures amounted to 10,000. Franklin was chosen colonel of the Philadelphia regiment, but he did not think proper to accept of the honour.

Pursuits of a different nature now occupied the greatest part of his attention for some years. Being always much addicted to the study of natural philosophy, and the discovery of the Leyden experiment in electricity having rendered that science of general curiosity, Mr. Franklin applied himself to it, and soon began to distinguish himself in that way. He engaged in a course of electrical experiments with all the ardour and thirst for discovery which characterized the philosophers of that day. By these he was enabled to make a number of important discoveries, and to propose theories to account for various phenomena, which have been generally adopted, and will probably endure for a long time. His observations he communicated in a series of letters to his friend Mr. Collinson, the first of which is dated March 28, 1747. In these he makes known the power of points in drawing and throwing off the electric matter, which had hitherto escaped the notice of electricians. He also made the discovery of *plus* and *minus*, and of *positive* and *negative* state of electricity; from whence, in a satisfactory manner, he explained the phenomena of the Leyden phial, first observed by Cuneus, or Muschenbroech, which had much perplexed philosophers. He shewed that the bottle, when charged, contained no more electricity than before, but that as much was taken from one side as was thrown on the other, and that to discharge it, it was necessary to make a communication between the two sides, by which the equilibrium might be restored, and that then no signs of electricity would remain. He then demonstrated, by experiments, that the electricity did not reside in the coating, as had been supposed, but in or upon the glass itself. After a phial was charged, he

removed the coating, and found that upon applying a new coating, the shock might still be received. In the year 1749 he first suggested his idea of explaining the phenomena of thunder-gusts, and of the aurora borealis, upon electrical principles. He pointed out many particulars in which lightning and electricity agreed, and he adduced many facts, and reasoning from facts, in support of his positions. In the same year he conceived the bold and grand idea of ascertaining the truth of his doctrine by actually drawing down the forked lightning by means of sharp pointed iron rods, raised in the region of the clouds, from whence he derived his method of securing buildings and ships from lightning. It was not until the summer of 1752 that he was enabled to complete his grand discovery of the electrical kite, which being raised up into the clouds, brought thence the electricity or lightning down to the earth, and M. D'Alebard made the experiment about the same time in France, by following the track which Franklin had before pointed out.

The letters which he sent to Mr. Collinson, it is said, were refused a place among the papers of the Royal Society of London, and Mr. Collinson published them in a separate volume, under the title of New Experiments and Observations on Electricity, made at Philadelphia, in America; which were read with avidity, and soon translated into different languages. His theories were at first opposed by many philosophers, some of them members of the Royal Society of London; but in 1755, when he returned to that city, they voted him the gold medal which is annually given to the person who presents the best paper on some interesting subject. He was also admitted a member of the society, and had the degree of doctor of laws conferred upon him by several universities; but at this time, by reason of the war, which broke out between Great Britain and France, he returned to America, and interested himself in the public affairs of that country. Indeed, he had done this long before, for although philosophy was a principal object in Franklin's pursuit for several years, he did not confine himself to it alone. In the year 1747 he became a member of the General Assembly of Philadelphia. Being a friend to the rights of the people from his infancy, he soon distinguished himself as a steady opponent to the unjust schemes of the proprietaries. He was soon looked up to as the head of the opposition, and to him have been attributed many of the spirited replies of the Assembly to the messages of the governors. His influence in the body was very great; this arose not from any superior powers of eloquence, he spoke but seldom, and he was never known to make an elaborate harangue; his speeches often consisted of a single sentence, or a well told story, the moral of which was always obviously to the point. He never attempted the flowery fields of oratory; his manner was plain and mild; his style in speaking was like that of his writings, simple, unadorned, and remarkably concise. With this plain manner, and his penetrating and solid judgment, he was able to confound the most eloquent and subtle of his adversaries, to confirm the opinions of his friends, and to make converts of the unprejudiced who had opposed him; with a single observation he has rendered of no avail a long and elegant discourse, and determined the fate of a question of importance.

In the year 1749, he proposed the plan of an academy to be erected in the city of Philadelphia as a foundation for prosperity, to erect a seminary of learning more extensive and suitable to future circumstances: and in the beginning of 1750, three of the schools were opened, namely, the Latin and Greek schools, the Mathematical, and the English schools. This foundation soon after gave rise to another more extensive college, incorporated by charter, May 27, 1755, which still subsists, and in a very flourishing condition. In 1752, he was instrumental in the establishment of the Pennsylvania Hospital, for the cure and relief of indigent invalids, which has proved of the greatest use to that class of persons. Having conducted himself so well as Post-master to Philadelphia, he was, in 1753, appointed Deputy Post-master General to the whole of the British colonies.

The colonies being much exposed in their frontiers to depredations by the Indians and the French; at a meeting of commissioners for several provinces, Mr. Franklin proposed a plan for their general defence, to establish in the colonies a general government, to be administered by a president general, appointed by the crown, and by a grand council, consisting of members chosen by the representatives of the different colonies; a plan which was unanimously agreed to by the commissioners present. The plan, however, had a singular fate: it was disapproved of by the ministry of Great Britain, because it gave too much power to the representatives of the people; and it

was regretted by every assembly as giving to the president general, who was to be the representative of the crown, an influence greater than appeared to them proper in a plan of government intended for freemen. Perhaps this rejection, on both sides, is the strongest proof that could be adduced of the excellence of it, as suited to the situation of Great Britain and America at that time. It appears to have steered directly in the middle, between the opposite interests of both. Whether the adoption of this plan would have prevented the separation of America from Great Britain, is a question which might afford much room for speculation.

In the year 1755, General Braddock, with some regiments of regular troops and provincial levies, was sent to dispossess the French of the posts upon which they had seized in the back settlements. After the men were all ready, a difficulty occurred which had nearly prevented the expedition: this was the want of waggons. Franklin now stepped forward, and with the assistance of his son, in a little time, procured 150. After the defeat of Braddock, Franklin introduced into the assembly a bill for organizing a militia, and had the dexterity to get it passed. In consequence of this act a very respectable militia was formed, and Franklin was appointed colonel of the regiment of Philadelphia, which consisted of 1200 men; in which capacity he acquitted himself with much propriety, and was of singular service; though this militia was soon after disbanded by the English ministry.

In 1757, he was sent to England with a petition to the king and council, against the proprietaries who refused to bear any share in the public expenses and assessments, which he got settled to the satisfaction of the state. After the completion of this business, Franklin remained at the court of Great Britain for some time, as agent to the province of Pennsylvania; and also for those of Massachusetts, Maryland, and Georgia. Soon after this he published his Canada pamphlet, in which he pointed out, in a very forcible manner, the advantages that would result from the conquest of this province from the French. An expedition was accordingly planned, and the command given to General Wolfe; the success of which is well known. He now divided his time, indeed, between philosophy and politics, rendering many services to both. Whilst here, he invented the elegant musical instrument called the Armonica, formed of glasses, played upon by the fingers.

In the summer of 1762, he returned to America; on his passage to which he observed the singular effect produced by agitation of a vessel containing oil floating on water: the upper surface of the oil remained smooth and undisturbed, whilst the water was agitated with the utmost commotion. On his return he received the thanks of the Assembly of Pennsylvania, which having annually elected him a member in his absence, he again took his seat in this body, and continued a steady defender of the liberties of the people.

In 1764, by the intrigues of the proprietaries, Franklin lost his seat in the assembly, which he had possessed for 14 years; but he was immediately appointed provincial agent to England, for which country he presently set out.

In 1766, he was examined before the parliament relative to the stamp act; which was soon after repealed. The same year he made a journey into Holland and Germany, and another into France; being every where received with the greatest respect by the literati of all nations.

In 1773, he attracted the public attention by a letter on the duel between Mr. Whately and Mr. Temple, concerning the publication of Governor Hutchinson's letters, declaring that he was the person who had discovered those letters. On the 29th of January, next year, he was examined before the privy-council, on a petition he had presented long before, as agent for Massachusetts Bay, against Mr. Hutchinson; but this petition being disagreeable to the ministry, it was precipitately rejected, and Dr. Franklin was soon after removed from his office of Post-master General for America. Finding now all efforts to restore harmony between Great Britain and her colonies useless, he returned to America in 1775, just after the commencement of hostilities. Being named one of the delegates of the Continental Congress, he had a principal share in bringing about the revolution and declaration of independency on the part of the colonies.

In 1776, he was deputed by Congress to Canada, to negociate with the people of that country, and to persuade them to throw off the British yoke; but the Canadians had been so much disgusted with the hot zeal of the New Englanders, who had burnt some of their chapels, that they re-

fused to listen to the proposals, though enforced by all the arguments Dr. Franklin could make use of. On his return to Philadelphia, Congress, sensible how much he was esteemed in France, sent him there to put a finishing hand to the private negociation of Mr. Silas Deane; and this important commission was readily accepted by the doctor, though then in the 71st year of his age: the event is well known; a treaty of alliance and commerce was signed between France and America; and M. le Roi asserts, that the doctor had a great share in the transaction, by strongly advising M. Maurepas not to lose a single moment if he wished to secure the friendship of America, and to detach it from the mother country.

In 1777, he was regularly appointed Plenipotentiary from Congress to the French court; but obtained leave of dismission in 1780. Having at length seen the full accomplishment of his wishes, by the conclusion of the peace in 1783, which gave independence to America, he became desirous of revisiting his native country: he therefore requested to be recalled; and, after repeated solicitations, Mr. Jefferson was appointed in his stead. On the arrival of his successor, he repaired to Havre de Grace, and, crossing the channel, landed at Newport in the Isle of White, from whence, after a favourable passage, he arrived safe at Philadelphia, in September 1785. He was received amidst the acclamations of a vast multitude, who flocked from all parts to see him, and who conducted him in triumph to his own house; where in a few days he was visited by the members of Congress, and the principal inhabitants of Philadelphia. He was afterwards twice chosen President of the Assembly of Philadelphia; but his increasing infirmities obliged him to ask permission to retire and spend the remainder of his life in tranquillity, which was granted in 1788. After this the infirmities of age increased fast upon him; he became more and more afflicted with the gout and the stone till the time of his death, which happened the 17th of April, 1790, about 11 o'clock at night, at 84 years of age, leaving one son, Governor William Franklin, a zealous loyalist, who now resides in London; and a daughter, married to Mr. William Beach, merchant in Philadelphia.

Dr. Franklin was author of many tracts on electricity and other branches of natural philosophy, as well as on political and miscellaneous subjects. He had also many papers inserted in the Philosophical Transactions, from the year 1757 to 1774.

FRANKS. See Letter.

FRAPPING, in naval affairs, the act of crossing and drawing together the several parts of the tackle, or other complication of ropes, which had been already strained to their utmost extent; in this sense it resembles the operation of bracing a drum. The frapping increases tension, and consequently adds to the security acquired by the purchase.

FRAUD. All deceitful practices in defrauding, or endeavouring to defraud, another of his own right, by means of some artful device, contrary to the plain rules of common honesty, are condemned by the common law, and punishable according to the heinousness of the offence.

The distinction laid down, as proper to be attended to in all cases of this kind, is this, that in such impositions or deceits, where common prudence might guard persons from the offence, it is not indictable, but the party is left to his civil remedy; but where false weights or measures are used, or false tokens produced, or such measures taken to defraud or deceive, as people cannot by any ordinary care or prudence be guarded against, there it is an offence indictable. Persons convicted of obtaining money or goods by false pretences, or sending threatening letters to extort money or goods, may be punished by fine and imprisonment, or by pillory, whipping, or transportation. 30 G. II. c. 24.

FRAXINUS, in botany, English *ash-tree*, a genus of the Polygamia Dioecia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: hermaphrodite; calyx none, or four-parted; corolla none, or four-petalled; stamins two; pistal one; seed or capsule one, lanceolate. There are four species. The wood of the ash-tree is in great use among several artificers, as wheel-wrights, cart-wrights, carpenters, turners, &c. also for making ploughs, harrows, axle-trees, oars, &c. It is said to be as lasting for building as oak, and often preferred before it; though the timber of the trunk greatly excels that of a bough. Some ash is also so curiously veined, that the cabinet-makers think it equal to ebony, and call it green ebony; so that the woodmen, who light upon such trees, may have for it what they will. The season for felling this tree, is from November to February; for if cut down too early, or too late, it is liable to

the worm. The ash is hurtful to corn lands, and therefore should be planted either in hedges or clumps, at about nine or ten feet distance.

FRECKLES, spots of a yellowish colour, of the bigness of a lentile-seed, scattered over the face, neck, and hands. Freckles are either natural, or proceeding accidentally from the jaundice, or the action of the sun upon the part. Heat, or a sudden change of the weather, will often cause the skin to appear of a darker colour than natural, and thereby produce what is called tan, sunburn, &c. which seem to differ only in degree, and usually disappear in winter.

Persons of a fine complexion, and those whose hair is red, are the most subject to freckles, especially in those parts which they expose to the air.

FREE *bench*, in law, is the widow's share of her husband's copyhold, or customary lands, in the nature of dower, which is variable according to the customs in different places. In some manors it is one third, sometimes half, sometimes the whole during her widowhood, of all the copyhold or customary land which her husband died possessed of. In some places, by custom, she holds them only during her chaste viduity.

FREEHOLD may be in deed or in law. A freehold in deed, is actual seisin of lands or tenements in fee-simple, fee-tail, or for life. A freehold in law, is a right to such lands or tenements before entry or seizure. So there is a seisin in deed, and a seisin in law; a seisin in deed, is when a corporal possession is taken, and a seisin in law is where lands descend before entry, or where something is done which amounts in law to an actual seisin. Tenant in fee-simple, or fee-tail, for life, is said to have a freehold, so called, because it distinguishes it from term of years, chattels upon certain interests, lands in villenage, or customary or copyhold lands. See FEE-SIMPLE. A freehold cannot be conveyed to pass in futuro, for then there would be want of a tenant against whom to bring a præcipe, and therefore, notwithstanding such conveyance, the freehold continues in the vendor; but if livery of seisin be afterwards given, the freehold from thence passes to the vendee. A man is said to be seised of freehold, but to be possessed of other estates, as of copyhold lands, leases for years, or goods and chattels. See ESTATE and FEE-SIMPLE.

FREE *stone*, a whitish stone, dug up in many parts of England, that works like alabaster, but is more hard and durable; being of excellent use in building, &c. It is a kind of the grit-stone, but finer sanded, and a smoother stone, and is called free, from its being of such a constitution as to cut freely in any direction: such is the Portland-stone, and the free-stone of Kent.

FREIGHT is the consideration money agreed to be paid for the use or hire of a ship, or, in a larger sense, the burthen of such ship. The freight is most frequently determined for the whole voyage, without respect to time; sometimes it depends on time; in the former case it is either fixed at a certain sum for the whole cargo, or so much per ton, barrel, bulk, or other weight or measure, or so much per cent. on the value of the cargo. If a certain sum be agreed on for the freight of the ship, it must all be paid, although the ship, when measured, should prove smaller, unless the burthen be warranted. If the ship be freighted for transporting cattle or slaves, at so much per head, and some of them die on the passage, freight is only due for such as are delivered alive; if for lading them, it is due for all put on board. When a whole ship is freighted, if the master suffer any goods besides those of the freight to be put on board, he is liable for damages. If the voyage be completed according to the agreement, without any accident, the master has a right to demand the freight before the delivery of the goods; but if such delivery is prevented by negligence, or accidents, the parties will be reciprocally responsible in the following manner: If the merchant should not load the ship within the time agreed on, the master may engage with another, and recover damages. If the merchant recal the ship after she is laden and sailed, he must pay the whole freight; but if he unload before the ship has actually sailed, he will in such case only be responsible for damages. If the merchant load goods which are not lawful to export, and the ship be prevented from proceeding on that account, he must nevertheless pay the freight. If the master be not ready to proceed on the voyage at the time stipulated, the merchant may load the whole, or part of the cargo, on board another ship, and recover damages; but any real casualties will release the master from all damages. If an embargo be laid on the ship before she sail, the charter-party is dissolved, and the merchant pays the expenses

of loading and unloading; but if the embargo be only for a short limited time, the voyage shall be performed when it expires, and neither party is liable for damages. If the master sail to any other port than that agreed on, without necessity, he must sail to the port agreed on at his own expense, and is also liable for any damages in consequence thereof. If a ship be taken by the enemy, and retaken or ransomed, the charter-party continues in force. If the master transfer the goods from his own ship to another, without necessity, and they perish, he is responsible for the full value, and all charges; but if his own ship be in imminent danger, the goods may be put on board another ship at the risk of the owner. If a ship be freighted out and home, and a sum agreed on for the whole voyage, nothing becomes due until the return of such ship. If a certain sum be specified for the homeward voyage, it is due, although the correspondent abroad should have no goods to send home. A ship was freighted to a particular port and home, a particular freight agreed upon for the homeward voyage, with an option reserved for the correspondent to decline it, unless the ship arrived before a certain day. The master did not go to the port agreed on, and therefore became liable to damages; the obligation being absolute on his part, and conditional only on the part of the freighter. If the goods be damaged without fault of the ship or master, the owner is not obliged to receive them and pay the freight; but he must either receive or abandon the whole, he cannot receive those that are not damaged, and reject the others. If the goods be damaged through the insufficiency of the ship, the master is liable for the same; but if it be owing to stress of weather, he is not accountable. If part of the goods be thrown overboard, or taken by the enemy, the part delivered pays freight. The master is accountable for all the goods received on board by himself and mariners, unless they perish by the act of God, or the king's enemies. The master is not liable for leakage of liquors, nor accountable for contents of packages, unless packed in his presence.

FRESCO, in painting, an Italian word now universally adopted, signifying paintings performed on the walls of palaces and churches. There cannot be a doubt, that this was the original method, in which all large subjects were done immediately after the discovery of the art of expressing forms and substances, by the judicious disposition of different coloured earths diluted with water. Savages found in a complete state of nature, who knew nothing more than her immediate dictates, have been found covered with colours, collected, and used on their persons by instinct; and some have even demonstrated genius, in working the beautiful mantles and helmets formed of feathers of the most vivid tints: one step more would have produced painting on walls, but it was reserved for the ancient Grecians to enlighten and benefit the world by the superior talents they had received and cultivated; it would be vain to enter into an investigation when their attempts arrived to that state of comparative perfection, which produced the delineation of figures on plaster or similar composition; we must, therefore, be satisfied with describing some still extant of very great antiquity, and mentioning the modern method of using the colours.

It may reasonably be supposed, that the first pictures painted in this way were extremely rude, and probably did not consist of more than two colours, a light one for the ground, and a dark for the outlines; for blending the tints must have been the result of experience, and some degree of freedom. This supposition may be illustrated by referring to the valuable vases brought from Herculaneum, by the late Sir William Hamilton, and now deposited in the British Museum; those, and the paintings found in the same city, were in all probability the performances of Italians, but as the art was then evidently in its infancy, the Greeks might not have excelled their imitators, indeed painting must have been considered by that ingenious people as an art inferior to that of sculpture, which accounts for the superior excellence, and earlier improvements, in the latter.

The appendix to the Abbé Barthelemy's travels in Italy contains several curious remarks on Herculaneum, by Count Caylus and others, and Du Theil; the latter supposes that the destruction of this city happened in the year 471. Caylus, on treating upon the ancient paintings discovered, observes, "As to their designing, it is dry, and hardly ever exceeds the idea of a fine statue. The composition is in general cold, for the same reason that the design is dry. In fact a figure is not grouped, though it

be placed with others; and statues, intended at first to stand alone, will, with difficulty, enter into composition without some alteration; though the Diana in the Thesus, and the woman with wings in the Telephus, are more contrasted, and have an air of motion.

"The general taste of the composition is remarkable, not only for its resemblance to statues, as I have observed before, but to bas reliefs also. It is clear that the authors had them present to their imagination, and that they had made on their minds a very lively impression.

"The demi-tints are of an olive grey, or of a yellowish or reddish cast, and the shades of red, mixed with black. The draperies, in general, are made with little plaits, formed of light and flexible stuffs, after the style of Roman sculpture." The picture of Telephus is, however, an exception, and seems to lead the author to think, that the artist who performed this piece, was superior to those who executed the others.

In the aggregate there are no groupes, harmony, or *claro obscuro*. Each figure stands, as it were, independent, with its own light and shade only, neither receiving reflected light from the next, nor casting shade on it; nor are the shades broken, but done with the same colour as the half tints, and have merely less white; this peculiarity arose from their deficiency in the science of perspective, which reduced the artist to the necessity of making the graduation of distance by the faintness of his colours. "For the rest," adds the Count, "the pictures are done with ease, the touch is bold, and the pencil handled freely, the colouring being sometimes laid on patches, and sometimes softened down; in a word, the execution is light, and in the same style nearly as we paint the decorations of our theatres, the whole indicating a great practice in the artists."

Thus much is considered necessary, in order to show that the adoption of many colours in Fresco paintings, took place subsequent to 471; like all other arts, it must have been improved by degrees, and it cannot be doubted, that the great masters, whose labours still adorn the numerous churches and palaces in Italy, contributed largely to its perfection, though it is well known that many of their best works have suffered from damps, which it is presumed will prevent their stability wherever it prevails. This circumstance has operated to so great a degree in St. Peter's at Rome, that most of the old pictures have been replaced by others in Mosaic. See MOSAIC.

The same cause has prevented the frequent use of Fresco painting in England, except in mansions where a dry air is constantly preserved, the necessity of this precaution is demonstrated at present in the dome of St. Paul's. The manner of performing this description of painting, is to work while the plaster is wet which covers the wall to be decorated, consequently, in the execution of large subjects, the process of plastering must immediately precede the brush of the artist, and only in the proportion he works, that the colours may incorporate with the composition, and that it may not absorb the water which dilutes them, and prevent the free touches intended for effect.

Vitruvius, who calls Fresco painting *udo tectorio*, gives an accurate account of the extreme care which the ancients thought necessary in preparing the stuccoes for the colours, and it must be admitted that they succeeded admirably, when we consider how very perfect the remains of their productions now are, after undergoing the sulphurous inhumation of ashes, caused by the eruption of Vesuvius, one thousand three hundred and thirty seven years past. The moderns, however, conceive that their lime and sand is preferable.

The design intended for a wall, should be drawn on paper, or any substance from whence it may be transferred to the wet plaster; the mode of proceeding must afterwards be similar to that practised in painting upon canvass. The colours should be earths, exclusively, diluted with water sufficiently to make them flow freely, but not to decompose the plaster and mix its surface with them; long soft haired brushes should therefore be preferred.

FRESH *suit*, in law, is such a ready and earnest following of an offender, as never ceases from the time of the offence being committed or discovered, until he be apprehended; and the effect of this, in the pursuit of a felon, is, that the party pursuing shall have his goods again, whereas otherwise, they are forfeited to the King. Anciently the law was strict in this case, but now the goods are, in all cases, restored to the party.

FRESH, a term used at sea, to signify a strong, but not violent or dangerous wind:

hence, when the gale increases, it is said to freshen. In the plural, the word implies the impetuosity of an ebb-tide, increasing by heavy rains and flowing out into the sea, which it often discolours to a considerable distance from the shore, so that the line which divides the two colours, may be perceived distinctly for a great length along the coast.

FRET, or FRETTE, in architecture, a kind of knot or ornament, consisting of two lists or small fillets, variously interlaced or interwoven, and running at parallel distances equal to their breadth.

FRET, in heraldry, a bearing composed of six bars, crossed, and variously interlaced.

FRET, in music, signifies a kind of stop on some instruments, particularly bass-viols and lutes. Frets consist of strings tied round the neck of the instrument at certain distances, within which such and such notes are to be found.

FRET *work*, that adorned with frets. It is sometimes used to fill up and enrich flat empty spaces, but is mostly practised in roofs, which are fretted over with plaster-work. The Italians also use fret-works in the mantling of chimneys, with great figures; a cheap piece of magnificence, and as durable almost within doors, as harder matters in the weather.

FRICTION, in mechanics, the rubbing of the parts of engines and machines against each other, by which means a great part of their effect is destroyed.

It is hardly possible to lay down general rules concerning the quantity of friction, since it depends upon a multiplicity of circumstances, as the structure, firmness, elasticity, &c. of the bodies rubbing against each other. Some authors make friction upon an horizontal plane, equal to one-third of the weight to be moved; whilst others have found it to be considerably less. Two objects must, however, be observed, *viz.* the loss of power which is occasioned by it, and the contrivances which have been made, and are in use, for the purpose of diminishing its effects. A body of an horizontal plane should be capable of being moved by the application of the least force; but this is not the case, and the principal causes which render a greater or less quantity of force necessary for it, are, 1, the roughness of the contiguous surfaces; 2, the irregularity of the figure, which arises either from the imperfect workmanship, or from the pressure of one body from the other; 3, an adhesion, or attraction, which is more or less powerful according to the nature of the bodies in question; and 4, the interposition of extraneous bodies, such as moisture, dust, &c.

Innumerable experiments have been made for the purpose of determining the quantity of obstruction, or of friction, which is produced in particular circumstances. But the results of apparently similar experiments, which have been made by different experimenters, do not agree; nor is it likely they should, since the least difference of smoothness or polish, or of hardness, or in short, of any of the various concurring circumstances, produces a different result. Hence no certain and determinate rules can be laid down with respect to the subject of friction. Mr. Vince, who has done much on this subject, infers, 1, That friction is an uniformly retarding force in hard bodies, not subject to alteration by the velocity, except when the body is covered with cloth, woollen, &c. and in this case the friction increases a little with the velocity. 2, Friction increases in a less ratio than the quantity of matter or weight of the body. This increase, however, is different for the different bodies, more or less, nor is it yet sufficiently known for any one body, what proportion the increase of friction bears to the increase of weight. 3, The smallest surface has the least friction, the weight being the same. But the ratio of the friction to the surface is not yet accurately known. Mr. Vince's experiments consisted in determining how far the sliding bodies would be drawn in given times, by a weight hanging freely over a pulley. This method would both shew him if the friction was a constant retarding force, and the other conclusions above stated. For as the spaces described by any constant force, in given times, are as the squares of the times, and as the weight drawing the body is a constant force, if the friction, which acts in opposition to the weight, should also be a constant force; then their difference, or the force by which the body is urged, will also be constant, in which case the spaces described ought to be as the squares of the times, which happened accordingly in the experiments. The friction, *cæteris paribus*, increases with the weight of the superincumbent body, and almost in the same proportion. The friction, or obstruction which arises from the bending of ropes about machines, is influenced by a variety of circumstances, such as their peculiar quality, the temperature of the atmosphere, and the diameter, or curvature

of the surface to which they are to be adapted. But when other circumstances remain the same, the difficulty of bending a rope increases with the square of its diameter, as also with its tension; and it decreases according as the radius of the curvature of the body to which it is adapted increases. Of the simple mechanical powers, the lever is the least subject to friction. In a wheel, the friction upon the axis is, as the weight that lies upon it, as the diameter of the axis, and as the velocity of the motion. But upon the whole, this sort of friction is not very great, provided the machine is well executed. In common pulleys, especially those of a small size, the friction is very great. It increases in proportion as the diameter of the axis increases, as the velocity increases, and as the diameter of the pully decreases. With a moveable tackle, or block of five pulleys, a power of 150 pounds will barely be able to draw up a weight of 500 pounds. The screw is subject to a great deal of friction; so much so, that the power which must be applied to it, in order to produce a given effect, is at least double that which is given by the calculation, independent of friction. But the degree of friction in the screw, is influenced considerably by the nature of the construction, for much of it is owing to the tightness of the screw, to the distance between its threads, and to the shape of the threads; the square threads producing, upon the whole, less friction than those which are sharp. The friction which attends the use of the wedge, exceeds, in general, that of any other simple mechanical power. Its quantity depends so much upon the nature of the body upon which the wedge acts, besides other circumstances, that it is impossible to give even an approximate estimate of it. The friction of mechanical engines not only diminishes the effect, or which is the same thing, occasions a loss of power; but is attended with the corrosion and wear of the principal parts of the machine, besides producing a considerable degree of heat, and even actual fire; it is, therefore, of great importance, in mechanics, to contrive means capable of diminishing, if not of quite removing, the effects of friction.

The methods of obtaining the important object of diminishing the friction, are of two sorts, *viz.* either by the interposition of particular unctuous, or oily substances between the contiguous moving parts, or by particular mechanical contrivances. Olive-oil is the best, and perhaps the only substance that can be used in small works, as in watches and clocks, when metal works against metal. But in large works the oil is liable to drain off, unless some method is adopted to confine it. Therefore for large works tallow is mostly used, or grease of any sort, which is useful for metal, as well as for wood. In the last case tar is also frequently used. The mechanical contrivances which have been made, and are in use, for the purpose of diminishing the effects of friction, consist either in avoiding the contact of such bodies as produce much friction, or in the interposition of rollers, *viz.* cylindrical bodies, between the moving parts of machines, or between moving bodies in general. Such cylinders derive, from their various size and application, the different names of rollers, friction wheels, and friction rollers. Thus in mill-work, and other large machines, the wooden axis of large wheels terminate in iron gudgeons, which turn in wood, or more frequently in iron or brass, which construction produces less friction than the turning of wood in wood. In the finest sort of watch-work the holes are jewelled, *viz.* many of the pivots of the wheels, &c. move in holes made in rubies, or topazes, or other hard stone, which, when well finished, are not liable to wear, nor do they require much oil. In order to understand the nature of rollers, and the advantage with which their use is attended, it must be considered, that when a body is dragged over the surface of another body, the inequalities of the surfaces of both bodies meet and oppose each other, which is the principal cause of the friction or obstruction; but when one body, such as a cask, a cylinder, or a ball, is rolled upon another body, the surface of the roller is not rubbed against the other body, but is only successively applied to, or laid, on the other, and is then successively lifted up from it. Therefore, in rolling, the principal cause of friction is avoided, besides other advantages: hence a body may be rolled upon another body, when the shape admits of it, with incomparably less exertion than that which is required to drag it over the surface of that other body. In fact, we commonly see large pieces of timber, and enormous blocks of stone, moved upon rollers that are laid between them and the ground, with ease and safety, when it would be almost impossible to move them otherwise.

Friction, is a term made use of in medicine, and implies the act of rubbing a diseased part with oils, or other substances.

Friction is also applied to the rubbing the human body with a flesh-brush, flannel, &c.; but the most important purpose of this kind of friction is for the introduction of mercury into the habit by means of the skin instead of the mouth.

FRIEND, or *quaker*. A society of dissenters from the church of England obtained the latter appellation in the middle of the seventeenth century; the former they had before applied, and continue to apply, to themselves. The first preacher of this society was George Fox, a man of humble birth, and illiterate. The undertaking to which he considered himself called, that of promulgating a more simple and spiritual form of Christianity than any of those which prevailed, and of directing the attention of Christians to immediate revelation, required little more reading than that of the Bible. A constant reference to the scriptures, with great zeal, courage, and perseverance, in preaching and suffering, did more than literature could have done to spread his doctrine among the middle and lower classes. The most prominent feature in the Friends' view of Christianity, is this: seeing, no man knoweth the Father but the Son, and he to whomsoever the Son will reveal him, and seeing, the revelation of the Son is in and by the Spirit; therefore the testimony of the Spirit is that alone by which the true knowledge of God is revealed. In this doctrine they agree, in substance, with the church of England, and all others who acknowledge the efficacy of grace. For in whatever way this is afforded to Christians, it is powerfully given to know and to do the will of God; and the communication of grace may be termed, in strict consistency with the sense of the New Testament, a revelation of Christ in the Spirit. The Friends receive the Holy Scriptures as having proceeded from the revelations of the Holy Spirit; they account them the secondary rule for Christians, subordinate to the word, and therefore not the word of God. According to these, they profess their belief in one God, as Father, Word, and Holy Spirit; in one Mediator, the Word made flesh, Jesus Christ; in the conception, birth, life, miracles, death, resurrection, and ascension of Jesus; and in the remission of sins thereby purchased for the whole world of fallen mankind. Christ's redemption they believe to be perfected in us by his second coming in Spirit; in which they who obey him are, through the obedience of faith, restored from their state of alienation, and reconciled to God. They affirm, that for this end there is given to every man a measure of the light of Christ, (called by their early preachers the light within) a manifestation of the Spirit to profit withal; which discovers sin, reproves for it, leads out of it, and, if not resisted, will save from it, and lead on the Christian to perfection. In public worship they profess to wait on God in this gift, in order to have their conditions made manifest in silence and retirement of mind. They look for an extraordinary motion of it for social worship, and considering the qualification of a minister as a further gift which God confers, and of which the church ought to judge in the same spirit, they do not limit its exercise to any description of persons. They suffer some inconvenience hereby, as they acknowledge; but they prefer bearing this to the establishing of any form of worship, save the forementioned waiting in silence. They do not baptize formally, or use the sign of the communion; they say the one has ceased as to obligation, and that the true administration of the other is by the spirit alone. They deem it unlawful for Christians to swear at all; and their affirmation in civil causes is made legal instead of an oath. They refuse to "learn war, or to lift up the sword," as well as to contribute directly to military proceedings. Yet as they inculcate implicit submission, actively or passively, to Cæsar, they neither resist nor evade the legal appropriation of their substance by him, as well to these as to ecclesiastical purposes. Against the claims of the clergy, as well as many other things apparently lawful, they say in their phraseology they have a testimony to bear. Some peculiarities mark them out from their fellow citizens. Simplicity in dress, in some instances, nearly amounting to an adherence to their original, though not prescribed, costume; simplicity of language, thou to one person, and without compliments; simplicity in their manners of living; the non-observance of fasts and feasts; the rejection of those which they call the unchristian names of days and months; and the renunciation of the theatres and other promiscuous amusements, gaming, and the usual outward signs of mourning and rejoicing, may be considered as their *shibboleth*. They marry among themselves by a ceremony or contract, religiously conducted, and bury their dead in the most simple manner. They maintain their poor, and enforce their own rules, by means of an excellent system of

discipline, founded by G. Fox. They receive approved applicants into their society by an act of monthly meeting, or particular congregation, and without subscription of articles. They disown in the same manner, after repeated admonition, not officially only, but actually extended, to offenders against morality, or their peculiar rules.

FRIEZE, FREEZE, or FRIZE, in architecture, a large flat face, or member, separating the architrave from the corniche, being that part of the entablature between the architrave and corniche. See ARCHITECTURE.

FRIGATE, among seamen, a ship of war, light built, and that is a good sailer. A frigate has commonly two decks, whence that called a light frigate is a frigate with only one deck. These vessels mount from 20 to 44 guns, and make capital cruizers. Merchantmen are said to be frigate-built, when the disposition of the decks have a descent of four or five steps from the quarter-deck and forecastle into the waist, in contradistinction to those whose decks are on a continued line for the whole length of the ship, which are called galley-built. Formerly the name of frigate was only known in the Mediterranean, and applied to a kind of long vessels navigated in that sea with sails and oars. Our countrymen were the first who appeared in the ocean with those ships, and equipped them for war as well as commerce.

FRINGILLA, the *finch*, in natural history, a genus of birds of the order Passeres. Generic character: bill perfectly conic, slender towards the end, and extremely pointed. Many of this tribe are truly admirable, both for the elegance of their plumage, and the vivacity and melody of their song. Latham enumerates 96 species, and Gmelin 111; of which we shall notice the following: F. domestica, or the house sparrow, is never found remote from human habitations; but following the society of man, builds under the roofs of houses, and in the holes of walls, and will frequently expel the martin from its nest, to save itself the trouble of preparing one of its own. It breeds generally three times in a year. By the destruction of caterpillars, these birds are eminently serviceable; but their favourite food is grain, to procure which they are constant attendants at the barn-door, and notwithstanding every effort to scare them, will dare every danger to partake of the repasts of the poultry and pigeons. They are particularly sagacious as well as daring, and can, with great difficulty only, be decoyed by traps. Their sounds are harsh and grating, their dispositions irascible, and their manners intrusive. F. cœlebs, or the chaffinch, is found in this country throughout the year, and builds its nest with extreme care and neatness, lining it with hair, wool, and feathers. It is sprightly in its movements, and beautiful in its plumage; but can boast no peculiar powers of melody. The most singular circumstance attending this species of birds is, that, in some countries, the males remain all the year round, while the females are migratory to the south, returning in the spring to their former habitations and companions. Flocks composed only of females have occasionally been seen in Hampshire. This circumstance is not peculiar to these birds, but affects equally some other descriptions. It is in itself, however, not a little curious, and merits attention. F. carduelis, or goldfinch, is common in Europe, and to be found, though by no means so frequently, in Africa and Asia. It breeds twice a year, and feeds principally on seeds, and especially those of thistles, near which it prefers building its nest, which is formed with great compactness and skill. It begins to sing in April, and continues its song till the period of breeding is past. In confinement, however, it will sing for the greater part of the year. These birds are universally admired for the brilliancy of their plumage, and the melody of their sounds; and they possess, moreover, a docility which renders them particularly interesting, learning with ease a variety of ingenious movements and exercises. They are long lived, and have been known to survive the age of twenty years. Buffon mentions the case of a goldfinch which suddenly became black, and after continuing so for eight months, resumed its former sprightly and elegant colouring: this revolution was repeated at two subsequent periods. (See Aves, Plate VI. fig. 6.) F. Spinus, or the siskin, is found in various parts of Europe, generally migratory, but at irregular periods, and in very unequal numbers; the larger flights being supposed by some naturalists to occur only once in several years. It hides its nest with particular caution; and though vast numbers are to be seen on the borders of the Danube, which have not lost their original feathers, their nests have been sought, it is said, in the neighbourhood with great assiduity, but in very few instances with success. It is nearly as tractable as the goldfinch, has

great richness and variety of notes, and extraordinary power in imitating sounds. F. canaria, or canary finch. These birds constitute, to some little extent, an article of commerce, being exported from the Tyrol in considerable numbers every year to various other parts of Europe. Buffon enumerates no fewer than 29 varieties, and devotes 50 pages of his celebrated work to an interesting detail of their manners, habits, and song. They are bred and reared in England in aviaries with great facility; and the fidelity of their attachments, and delicacy of their attentions, their extreme neatness, parental affection, and animated and almost incessant music, constitute a source of pure and exquisite entertainment to all the admirers of artless and interesting nature. F. linaria, or the linnet, is to be met with in every part of Europe, and is particularly common in England, where it builds, generally, in thorns and furze bushes, and breeds twice in the year. Linnets feed on various seeds; but particularly relish those of the flax plant, from the Latin name for which *(linum)* they probably derive their name. They can be taught the notes of various other birds, and even to utter words with very distinct enunciation; but their natural song, expressive of tranquillity and rapture, and poured out in a strain of richly varied melody, is infinitely superior to these unmeaning and elaborate articulations. For the red-pole and the mountain-sparrow, see Aves, Plate VI. fig. 7 and 8.

FRIT, in the glass manufacture, the matter or ingredients whereof glass is to be made, when they have been calcined or baked in a furnace; or it is the calcined matter to be run into glass. See GLASS.

FRITILLARIA, in botany, *imperial fritillary*, or *crown imperial*, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Lilia, Jussieu. There are five species with many varieties.

FRIZING *of cloth*, a term in the woollen manufactory, applied to the forming of the nap of a cloth, or stuff, into a number of little hard burrs or prominences, covering almost the whole ground thereof. Some cloths are only freezed on the backside, as black cloths; others on the right side, as coloured and mixed cloths, rateens, bays, freezes, &c. Frizing may be performed two ways; one with the hand, that is, by means of two workmen, who conduct a kind of plank that serves for a frizing instrument.

The other way is by a mill, worked either by water, or a horse, or sometimes by men. This latter is esteemed the better way of frizing, by reason the motion being uniform and regular, the little knobs of the frizing are formed more equably and regularly. The structure of this useful machine is as follows:

The three principal parts are the frizer or crisper, the frizing-table, and the drawer, or beam. The two first are two equal planks or boards, each about ten feet long, and fifteen inches broad, differing only in this, that the frizing-table is lined or covered with a kind of coarse woollen stuff, of a rough sturdy nap; and the frizer is incrustated with a kind of cement composed of glue, gum arabic, and a yellow sand, with a little aquavitæ, or urine. The beam, or drawer, thus called, because it draws the stuff from between the frizer and the frizing-table, is a wooden roller, beset all over with little, fine, short points, or ends of wire, like those of cards used in carding of wool.

The disposition and use of the machine is thus: the table stands immoveable, and bears or sustains the cloth to be frized, which is laid with that side uppermost on which the nap is to be raised: over the table is placed the frizer, at such a distance from it as to give room for the stuff to be passed between them, so that the frizer, having a very slow semicircular motion, meeting the long hairs or naps of the cloth, twists and rolls them into little knobs or burrs, while, at the same time, the drawer, which is continually turning, draws away the stuff from under the frizer, and winds it over its own points.

All that the workman has to do while the machine is a going, is to stretch the stuff on the table, as fast as the drawer takes it off; and from time to time to take off the stuff from the points of the drawer. The design of having the frizing-table lined with stuff of a short, stiff, stubby nap, is, that it may detain the cloth between the table and the frizer long enough for the grain to be formed, that the drawer may not take it away too readily, which must otherwise be the case, as it is not held by any thing at the other end.

FROG. See RANA.

FRONDESCENTIA, in botany, a term expressive of the precise time of the year and month, in which each species of plants unfolds its first leaves. All plants produce new leaves every year; but all do not re-

new them at the same time. Among woody plants, the elder, and most of the honeysuckles; among perennial herbs, crocus and tulip, are the first that push or expand their leaves. The time of sowing the seed decides with respect to annuals. The oak and ash are constantly the latest in pushing their leaves: the greatest number unfold them in spring; the mosses and firs in winter. These striking differences, with respect to so capital a circumstance in plants as that of unfolding their leaves, seem to indicate that each species of plant has a temperature proper or peculiar to itself, and requires a certain degree of heat to extricate the leaves from their buds, and produce the appearance in question. This temperature, however, is not so constant as, to a superficial observer, it may appear to be. Among plants of the same species, there are some more early than others; whether that circumstance depends, as it most commonly does, on the nature of the plants, or is owing to differences in heat, exposure, and soil. In general, it may be affirmed, that small and young trees are always earlier than larger or old ones. See Germination, and Milne's Bot. Dict.

FROST, such a state of the atmosphere as causes the congelation or freezing of water or other fluids into ice. In the more northern parts of the world, even solid bodies are affected by frost, though this is only or chiefly in consequence of the moisture they contain, which being frozen into ice, and so expanding as water is known to do when frozen, it bursts and rends any thing in which it is contained, as plants, trees, stones, and large rocks. Many fluids expand by frost, as water, which expands about $\frac{1}{10}$th part, for which reason ice floats in water; but others again contract, as quicksilver, and thence frozen quicksilver sinks in the fluid metal.

Frost, being derived from the atmosphere, naturally proceeds from the upper parts of bodies downwards, as the water and the earth: so, the longer a frost is continued, the thicker the ice becomes upon the water in ponds, and the deeper into the earth the ground is frozen. In about 16 or 17 days frost, Mr. Boyle found it had penetrated 14 inches into the ground. At Moscow, in a hard season, the frost will penetrate two feet deep into the ground: and Captain James found it penetrated 10 feet deep in Charlton Island, and the water in the same island was frozen to the depth of six feet. Sheffer assures us, that in Sweden the frost pierces two cubits, or Swedish ells into the earth, and turns what moisture is found there into a whitish substance, like ice; and standing water to three ells or more. The same author also mentions sudden cracks or rifts in the ice of the lakes of Sweden, nine or ten feet deep, and many leagues long; the rupture being made with a noise not less loud than if many guns were discharged together. By such means however the fishes are furnished with air; so that they are rarely found dead.

The natural history of frosts furnish very extraordinary effects. The trees are often scorched and burnt up, as with the most excessive heat, in consequence of the separation of water from the air, which is therefore very drying. In the great frost in 1683, the trunks of oak, ash, walnut, &c. were miserably split and cleft, so that they might be seen through, and the cracks often attended with dreadful noises like the explosion of fire arms. Philos. Trans. Number 165.

The close of the year 1708, and the beginning of 1709, were remarkable throughout the greatest part of Europe, for a severe frost. Dr. Derham says, it was the greatest in degree, if not the most universal in the memory of man; extending through most parts of Europe, though scarcely felt in Scotland or Ireland.

In very cold countries, meat may be preserved by the frost six or seven months, and prove tolerably good eating. See Captain Middleton's observations made in Hudson's Bay, in the Philos. Trans. Number 465, sect. 2.

In that climate the frost seems never out of the ground, it having been found hard frozen in the two summer months. Brandy and spirit, set out in the open air, freeze to solid ice in three or four hours.

Lakes and standing waters, not above 10 or 12 feet deep, are frozen to the ground in winter, and all their fish perish. But in rivers where the current of the tide is strong, the ice does not reach so deep, and the fish are preserved. Id. ib.

Some remarkable instances of frost in Europe, and chiefly in England, are recorded as below; in the year

220 Frost in Britain that lasted five months.

250 The Thames frozen nine weeks.

291 Most rivers in Britain frozen six weeks.

359 Severe frost in Scotland for 14 weeks.

508 The rivers in Britain frozen for two months.
558 The Danube quite frozen over.
695 Thames frozen six weeks; booths built on it.
759 Frost from Oct. 1, till Feb. 26, 760.
827 Frost in England for nine weeks.
859 Carriages used on the Adriatic Sea.
908 Most rivers in England frozen two months.
923 The Thames frozen 13 weeks.
987 Frost lasted 120 days: began Dec. 22.
998 The Thames frozen five weeks.
1035 Severe frost on June 24: the corn and fruits destroyed.
1063 The Thames frozen 14 weeks.
1076 Frost in England from Nov. till April.
1114 Several wooden bridges carried away by ice.
1205 Frost in England from Jan. 14, till March 22.
1407 Frost that lasted 15 weeks.
1434 From Nov. 24, till Feb. 10, Thames frozen down to Gravesend.
1683 Frost for 13 weeks.
1708-9 Severe frost for many weeks.
1715 The same for many weeks.
1739 One for nine weeks: began December 24.
1742 Severe frost for many weeks.
1747 Severe frost in Russia.
1751 Severe one in England.
1760 The same in Germany.
1776 The same in England.
1788 The Thames frozen below bridge; booths on it.
1794 Hard frost of many weeks. Ther. at London, mostly at 20 below 0 of Fahrenheit.

Hoar frost, is the dew frozen or congealed early in cold mornings; chiefly in autumn. Though many Cartesians will have it formed of a cloud; and either congealed in the cloud, and so let fall; or ready to be congealed as soon as it arrives at the earth.

Hoar frost, M. Regius observes, consists of an assemblage of little parcels of ice crystals, which are of various figures, according to the different disposition of the vapours, when met and condensed by the cold.

FROTH *spit*, or CUCKOW *spit*, a name given to a white froth, or spume, very common in the spring, and first months of the summer, on the leaves of certain plants, particularly on those of the common white-field lychnis or catch-fly. See CICADA.

FRUCTESCENTIA, in botany, comprehends the precise time in which, after the fall of the flowers, the fruits arrive at maturity, and disperse their seeds. In general, plants which flower in spring, ripen their fruits in summer, as rye; those which flower in summer, have their fruits ripe in autumn, as the vine; the fruit of autumnal flowers ripens in winter, or the following spring, if kept in a stove, or otherwise defended from excessive frosts. The time in which plants ripen their fruit, combined with that in which they germinate and unfold their leaves, gives the entire space or duration of their life, which, in the same species, is proportionably short or long, according to the greater or less intensity of heat of the climate, in which they are cultivated. In general, it appears, that if the heat is equal and uninterrupted, the time betwixt the germinating or sprouting and flowering of annual plants, is equal to the interval betwixt their flowering and the maturation of the fruits, or even the total destruction of the whole plant. In very hot climates, an annual plant generally lives as long before as after flowering. But in temperate climates, as France and England, plants which rise in spring and flower before the month of June, live a little longer before than after flowering; such as flower in summer, as barley and oats, which flower in June, live as long before as after; while the latter plants, which do not rise till autumn, live longer after flowering than before. These observations apply chiefly to herbaceous annuals. See Milne's Bot. Dict.

FRUSTUM, in mathematics, a part of some solid body separated from the rest.

The frustum of a cone is the part that remains, when the top is cut off by a plane parallel to the base; and is otherwise called a truncated cone. The frustum of a pyramid is also what remains after the top is cut off by a plane parallel to its base. To find the solid content of the frustum of a cone, pyramid, &c. the base being of any figure whatever: add the areas of the two ends, and the mean proportional between them together, then $\frac{1}{3}$ of that sum will be the mean area, or the area of an equal prism, of the same altitude with the frustum; and consequently that mean area multiplied by the height of the frustum, will give the solid content for the product:

If $A =$ area of the greater end
$a =$ ——— lesser end
$h =$ height : then

$$\frac{A + a + \sqrt{Aa}}{3} \times h = \text{the solidity.}$$

The frustum of a globe or sphere is any part thereof cut off by a plane, the solid contents of which may be found by this rule. To three times the square of the semidiameter of the base, add the square of its height; then multiplying that sum by the height, and this product multiplied by .5236, gives the solidity of the frustum. A frustum or portion of any solid, generated by the revolution of any conic section upon its axis, and terminated by any two parallel planes, may be thus compared to a cylinder of the same altitude, and whose base is equal to the middle section of the frustum made by a parallel plane. 1. The difference between such frustum and cylinder is always he same in different parts of the same or of similar solids; when the inclination of the planes to the axis, and the altitude of the frustum are given. 2. In the parobolic conoid, this difference vanishes; the frustum being always equal to a cylinder of the same height, upon the section of the conoid that bisects the altitude of the frustum, and is parallel to its bases. 3. In the sphere, the frustum is always less than the cylinder, by one fourth part of a right angled cone of the same height with the frustum; or, by one half of a sphere, of a diameter equal to that height: and this difference is always the same in all spheres whatever, when the altitude of the frustum is given. 4. In the cone, the frustum always exceeds the cylinder, by one fourth part of the content of a similar cone, that has the same height with the frustum.

As a general theorem: in the frustum of any solid, generated by the revolution of any conic section about its axis: if to the sum of the two ends be added four times the middle section, then the last sum divided by six will be the mean area, and being drawn into the altitude of the solid will produce the content: That is A and a being the areas of the ends; M equal the middle section then we have

$$\frac{A + a + 4M}{6} \times h = \text{solid content.}$$

This theorem holds good for complete solids as well as frustums, whether right or oblique, and not only of the solids generated from the conic sections, but also of all pyramids, cones, and in short of any solid, whose parallel sections are similar figures.

FUCHSIA, in botany, so called in honour of Leonard Fuchs, a famous German botanist, a genus of the Octandria Monogynia class and order. Natural order of Onagræ, Jussieu. Essential character: calyx one-leafed, coloured, bearing the corolla, very large; petals four, small; berry inferior, four-celled, with many seeds. There are five species.

FUCUS, in botany, a genus of the Cryptogamia Algæ. Generic character: male vesicles smooth, hollow, with villose hairs within, interwoven: female, vesicles smooth, filled with jelly, sprinkled with immersed grains, prominent at the tip. Seeds solitary. This genus comprehends most of those plants which are commonly called sea-weeds; more than seventy species are enumerated; they may all be used to manure land, or burnt for alkali. Some of the species are eaten, either fresh out of the sea; or boiled tender, with butter, pepper, &c. If the F. saccharinus is washed in spring water, and then hung up in a warm place, a substance like sugar exudes from it.

FUEL. Dr. Black divides fuels into five classes; the first comprehends the fluid inflammable bodies; the second, peat or turf; the third, charcoal of wood; the fourth, pit-coal charred; and the fifth, wood, or pit-coal, in a crude state, and capable of yielding a copious and bright flame.

The fluid inflammables are considered as distinct from the solid, on this account, that they are capable of burning upon a wick, and become in this way the most manageable sources of heat; though, on account of their price, they are never employed for producing it in great quantities; and are only used when a gentle degree, or a small quantity of heat is sufficient. The species which belong to this class are alcohol and different oils.

The first of these, alcohol, when pure and free of water, is as convenient and manageable a fuel for producing moderate or gentle heats as can be desired. Its flame is perfectly clean, and free from any kind of soot; it can easily be made to burn slower or faster, and to produce less or more heat, by changing the size or number of the wicks upon which it burns; for as long as these are fed with spirit, in a proper

manner, they continue to yield flame of precisely the same strength. The cotton, or other materials, of which the wick is composed, is not scorched or consumed in the least, because the spirit with which it is constantly soaked is incapable of becoming hotter than 174°, Fahrenheit, which is considerably below the heat of boiling water. It is only the vapour that arises from it which is hotter, and this too only in its outer parts, that are most remote from the wick, and where only the combustion is going on, in consequence of communication and contact with the air. At the same time, as the alcohol is totally volatile, it does not leave any fixed matter which, by being accumulated on the wick, might render it foul and fill up its pores. The wick, therefore, continues to imbibe the spirit as freely, after some time, as it did at the first. These are the qualities of alcohol as a fuel. But these qualities belong only to a spirit that is very pure. If, on the contrary, it be weak, and contain water, the water, being less volatile, does not evaporate so fast from the wick as the more spirituous part; and the wick becomes, after some time, so much soaked with water that it does not imbibe the spirit properly. The flame becomes much weaker, or is altogether extinguished. When alcohol is used as a fuel, therefore, it ought to be made as strong, or free from water, as possible.

Oil, although fluid like spirit of wine, and capable of burning in a similar manner, is not so convenient in many respects. It is disposed to emit soot; and this applying itself to the bottom of the vessel exposed to it, and, increasing in thickness, forms, by degrees, a soft and spongy medium, through which heat is not so freely and quickly transmitted. This was observed by Muschenbroeck in his experiments upon the expansions of metalline rods heated by lamps. It is true we can prevent this entirely, by using very small wicks, and increasing the number, if necessary, to produce the heat required. Or, we may employ one of those lamps, in which a stream of air is allowed to rise through the middle of the flame, or to pass over its surface with such velocity as to produce a more complete inflammation than ordinary. But we shall be as much embarrassed in another way, for the oils commonly used, being capable of assuming a heat greatly above that of boiling water, scorch and burn the wick, and change its texture, so that it does not imbibe the oil so fast as before. Some have attempted a remedy, by making the wick of incombustible materials, as asbestos, or wire; but still, as the oil does not totally evaporate, but leaves a small quantity of gross fixed carbonaceous matter, this, constantly accumulating, clogs the wick, to such a degree, that the oil cannot ascend, the flames become weaker, and, in some cases, are entirely extinguished. There is, however, a difference among the different oils in this respect; some being more totally volatile than others. But the best are troublesome in this way, and the only remedy is to change the wicks often, though we can hardly do this and be sure of keeping always an equal flame.

The second kind of fuel mentioned, peat, is so spongy that, compared with the more solid fuels, it is unfit to be employed for producing very strong heats. It is too bulky for this: we cannot put into a furnace, at a time, a quantity that corresponds with the quick consumption that must necessarily go on when the heat is violent. There is, no doubt, a great difference in this respect among different kinds of this fuel; but this is the general character of it. However, when we desire to produce and keep up, by means of cheap fuel, an extremely mild gentle heat, we can hardly use any thing better than peat. But it is best to have it previously charred, that is, scorched, or burnt to black coal. The advantages gained by charring have been already explained. When prepared for use in that manner, it is capable of being made to burn more slowly and gently, or will bear without being extinguished altogether, a greater diminution of the quantity of air, with which it is supplied, than any other of the solid fuels. Dr. Boerhaave found it extremely convenient and manageable in his Furnus Studiosorum.

The next fuel, in order, is the charcoal of wood. This is prepared by piling up billets of wood into a pyramidal heap, with several spiracles, or flues, formed through the pile. Chips and brushwood are put into those below, and the whole is so constructed that, when kindled, it kindles almost over the whole pile in a very short time. It would burst out into a blaze, and be quickly consumed to ashes, were it not covered all over with earth, or clay, beaten close, leaving openings at all the spiracles. These are carefully watched; and, whenever the white watery smoke is observed to be succeeded by thin blue, and transparent smoke, the whole is immediately stopped;

this being the indication of all the watery vapour being gone, and the burning of the true coaly matter commencing. Thus is a pretty strong red heat raised through the whole mass, and all the volatile matters are dissipated by it, and nothing now remains but the charcoal. The holes being all stopped in succession, as this change of the smoke is observed, the fire goes out for want of air. The pile is now allowed to cool. This requires many days; for, charcoal being a very bad conductor of heat, the pile long remains red hot in the centre, and, if opened in this state, would instantly burn with fury.

Small quantities may be procured at any time, by burning wood in close vessels. Little pieces may be very finely prepared, at any time, by plunging the wood in lead melted and red hot.

This is the chief fuel used by the chemists abroad, and has many good properties. It kindles quickly, emits few watery or other vapours while burning, and when consumed leaves few ashes, and those very light. They are, therefore, easily blown away, so that the fire continues open, or pervious to the current of air which must pass through it to keep it burning. This sort of fuel, too, is capable of producing as intense a heat as can be obtained by any; but in those violent heats it is quickly consumed, and needs to be frequently supplied.

Fossil coals charred, called cinders, or coaks, have, in many respects, the same properties as charcoal of wood; as kindling more readily in furnaces than when they are not charred, and not emitting watery, or other gross smoke, while they burn. This sort of charcoal is even greatly superior to the other in some properties.

It is a much stronger fuel, or contains the combustible matter in greater quantity, or in a more condensed state. It is, therefore, consumed much more slowly on all occasions, and particularly when employed for producing intense melting heats. The only inconveniences that attend it are, that, as it consumes, it leaves much more ashes than the other, and these much heavier too, which are, therefore, liable to collect in such quantity as to obstruct the free passage of air through the fire; and further, that when the heat is very intense these ashes are disposed to melt or vitrify into a tenacious drossy substance, which clogs the grate, the sides of the furnace and the vessels. This last inconvenience is only troublesome, however, when the heat required is very intense. In ordinary heat the ashes do not melt, and though they are more copious and heavy than those of charcoal of wood, they seldom choke up the fire considerably, unless the bars of the grate be too close together.

This fuel, therefore, is preferable, in most cases, to the charcoal of wood, on account of its burning much longer, or giving much more heat before it is consumed. The heat produced, by equal quantities, by weight of pit-coal, wood-charcoal and wood itself, are nearly in proportion of 5, 4, and 3. The reason why both these kinds of charcoal are preferred, on most occasions, in experimental chemistry, to the crude wood, or fossil coal, from which they are produced, is, that the crude fuels are deprived, by charring, of a considerable quantity of water, and some other volatile principles, which are evaporated during the process of charring, in the form of sooty smoke or flame. These volatile parts, while they remain in the fuel, make it unfit (or less fit) for many purposes in chemistry. For besides obstructing the vents with sooty matter, they require much heat to evaporate them; and therefore, the heat of the furnace, in which they are burnt, is much diminished and wasted by every addition of fresh fuel, until the fresh fuel is completely inflamed, and restores the heat to its former strength.

But these great and sudden variations of the heat of a furnace are quite inconvenient in most chemical processes. In the greater number of chemical operations, therefore, it is much more convenient to use charred fuel, than the same fuel in its natural state.

There are, at the same time, some kinds of fossil coal, which are exceptions to what has now been delivered in general. We meet with some of them that leave a smaller proportion of ashes than others, and the ashes of some are not so liable to melt in violent heats. There is one species too, such as the Kilkenny coal of Ireland, and which occurs likewise in some parts of this country, that does not contain any sensible quantity of water, or other such volatile principles. But this may be called a sort of native charcoal. It has the appearance of ordinary coal, but, when thrown into the fire, does not emit smoke or soot. It merely becomes red, gives a subtile blue flame, and consumes like charcoal; only it lasts surprizingly long, or continues to give heat for a very long time before it

is totally consumed. But it cannot be made to burn so as to produce a gentle heat. If not in considerable quantity, and violently heated, it is soon extinguished.

In using this kind of fuel, it is proper to be on our guard against the dangerous nature of the burnt air, which arises from charcoal of all kinds. Charcoal burns without visible smoke. The air arising from it appears to the eye as pure and as clear as common air. Hence it is much used abroad by those who are studious of neatness and cleanliness in their apartments. But this very circumstance should make us more watchful against its effects, which may prove dangerous, in the highest degree, before we are aware of it. The air arising from common crude fuel is no doubt as bad, but the smoke renders it disagreeable before it become dangerous. The first sensation is a slight sense of weakness; the limbs seem to require a little attention, to prevent falling. A slight giddiness, accompanied by a distinct feeling of a flush, or glow in the face and neck. Soon after, the person becomes drowsy, would sit down, but commonly falls on the floor insensible of all about him, and breathes strong, snoring as in an apoplexy. If the person is alarmed in time, and escapes into the open air, he is commonly seized with a violent head-ach, which gradually abates.

But when the effect is completed, as above described, death very soon ensues, unless relief be obtained. There is usually a foaming at the mouth, a great flush or suffusion over the face and neck, and every indication of an oppression of the brain, by this accumulation of blood. The most successful treatment is to take off a quantity of blood immediately, and throw cold water on the head repeatedly. A strong stimulus, such as hartshorn, applied to the soles of the feet, has also a very good effect.

The fifth and last kind of fuel is wood, or fossil coals, in their crude state, which it is proper to distinguish from the charcoals of the same substances. The difference consists in their giving a copious and bright flame, when plenty of air is admitted to them, in consequence of which they must be considered as fuels very different from charcoal, and adapted to different purposes. See Flame.

Flaming fuel cannot be managed like the charcoals. If little air be admitted, it gives no flame, but sooty vapour, and a diminution of heat. And if much air be admitted to make those vapours break out into flame, the heat is too violent. These flaming fuels, however, have their particular uses, for which the others are far less proper. For it is a fact, that flame, when produced in great quantity, and made to burn violently, by mixing it with a proper quantity of fresh air, by driving it on the subject, and throwing it into whirls and eddies, which mix the air with every part of the hot vapour, gives a most intense heat. This proceeds from the vaporous nature of flame, and the perfect miscibility of it with the air.

As the immediate contact and action of air is necessary to the burning of every combustible body; so the air, when properly applied, acts, with far greater advantage on flame, than on the solid and fixed inflammable bodies: for when air is applied to these last, it can only act on their surface, or the particles of them that are outermost; whereas flame being a vapour or elastic fluid, the air, by proper contrivances, can be intimately mixed with it, and made to act on every part of it, external and internal, at the same time. This great power of flame which is the conquence of this, does not appear when we try small quantities of it, and allow it to burn quietly, because the air is not intimately mixed with it, but acts only on the outside, and the quantity of burning matter in the surface of a small flame is too small to produce much effect.

But when flame is produced in large quantity, and is properly mixed and agitated with air, its power to heat bodies is immensely increased. It is therefore peculiarly proper for heating large quantities of matter to a violent degree, especially if the contact of solid fuel with such matter is inconvenient. Flaming fuel is used for this reason in many operations performed on large quantities of metal, or metallic minerals, in the making of glass, and in the baking or burning of all kinds of earthern ware. The potter's kiln is a cylindrical cavity, filled from the bottom to the top with columns of wares, the only interstices are those that are left between the columns; and the flame, when produced in sufficient quantity, proves a torrent of liquid fire, constantly flowing up through the whole of the insterstices, and heats the whole pile in an equal manner.

Flaming fuel is also proper in many works or manufactories, in which much fuel

is consumed, as in breweries, distilleries, and the like. In such works, it is evidently worth while to contrive the furnaces so that heat may be obtained from the volatile parts of the fuel, as well as from the fixed; for when this is done, less fuel serves the purpose than would otherwise be necessary. But this is little attended to, or ill understood in many of those manufactories. It is not uncommon to see vast clouds of black smoke and vapour coming out of their vents. This happens in consequence of their throwing too large a quantity of crude fuel, into the furnace at once. The heat is not sufficient to inflame it quickly, and the consequence is a great loss of heat. See LABORATORY.

FUGUE, in music, signifies a composition, in which one part leads off some determined succession of notes called the subject, which after being answered in the fifth and eighth by the other parts, is interspersed through the movement, and distributed amid all the parts in a desultory manner at the pleasure of the composer. There are three distinct descriptions of fugues, the simple, which contains but one subject; the double, that which consists of two subjects; and the counter fugue, is that in which the subjects move in a direction contrary to each other.

FUIRENA, in botany, so named in memory of George Fuiren, a genus of the Triandria Monogynia class and order. Natural order of Calamariæ. Cyperoideæ, Jussieu. Essential character: ament imbricate, with awned scales; calyx none; corolla with three-petal shaped obcordate glumes, ending in a tendril. There is but one species, *viz.* F. paniculata, a lofty grass. Native of Surinam and Jamaica.

FULCRUM, in mechanics, the prop or support, by which a lever is sustained. See MECHANICS.

FULGORA, in natural history, *lantern-fly*, a genus of insects of the order Hemiptera. Head hollow, inflated, extended forward; antennæ short, seated beneath the eyes, consisting of two joints, the outer one larger and globular; snout elongated, inflected, four-jointed; legs formed for walking. There are about 25 species, almost inhabitants of hot climates. Mr. Donovan has described the F. Europæa; the body of which is green; wings hyaline, reticulate; front conic. This is a small insect, and destitute of the shining quality, by which foreign species are distinguished. But the F. lanternaria, or Peruvian lantern-fly is one of the most curious of insects, it is three inches long, and the breadth between the tips of the expanded wings is about five or six inches. This beautiful insect is a native of Surinam and other parts of South America, and during the night it diffuses so strong a phosphoric splendor from its head, which is nearly as large as the rest of the body, that it may be employed for the purpose of a candle or torch.

FULICA, the *gallinule* and the *coot*, in natural history, a genus of birds of the order Grallæ. Generic character: bill strong, thick, and sloping to the point; upper mandible arched over the lower at the edge, and reaching far up the forehead; nostrils nearly oval; front bald; toes four, long and furnished with broad scalloped membranes. There are twenty-five species.

F. atra-coot, is distinguished from the gallinule by pinnated feet. It inhabits Europe, Asia, and America, and is about the size of a small fowl. It feeds on small fish and water-insects, is common in some parts of this country at all seasons, but in the breeding season is seen almost always in pairs, about the borders of ponds and lakes well fringed with rushes, of which it mats itself a large nest, said to be often observed floating on the water. These birds are devoured when young by the buzzards, which infest their haunts, and prevent them from that great multiplication which might be otherwise expected. Rallus crex, or the crake gallinule, is found in various parts of Europe, and is particularly abundant in Ireland, where it is supposed by Latham to winter. Wherever quails are, the crake is to be met with. It runs fast, but flies with great awkwardness, with its legs hanging down. Its food is grain and insects. On its arrival in England, where it is migratory, it is poor and emaciated, but fattens afterwards with great rapidity, and is esteemed excellent for the table. Its full weight is about eight ounces.

F. porphyrio or the purple water hen, occurs in almost all the warmer latitudes of the globe. It is of the size of a fowl; in Sicily is kept merely for its beauty, and in Persia exhibits its greatest elegance of plumage. It is tamed with great ease, and will feed very quietly in the farm-yard on grain or roots, but is particularly fond of fishes, which it plunges in the water before it takes them to its mouth. Standing on one leg it employs the other as a hand in many cases, particularly in lifting its food

AVES. Plate VII

Fig.1. Falco *Chrysaetos : Golden Eagle* _ *Fig.2.* F. Litho falco : *Stone Falcon* _ *Fig.3.* F. Ossifragus : *Osprey* _ *Fig.4.* Fulica *aterrima : Greater Coot* _ *Fig.5* . Glareola *Austriaca : Austrian Pratincole* _ *Fig.6.* Hæmatopus *Ostralagus : Pied Oyster-catcher.*

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Fig. 1. Cuculus *canorus: cuckoo* *Fig. 2.* Didus *ineptus: hooded dodo* *Fig. 3.* Diomedea *exulans: wandering albatross* *Fig. 4.* Emberiza *cirlus: cirl bunting* *Fig. 5.* E. *hyemalis. black headed bunting* *Fig. 6.* Fringilla *carduelis: goldfinch* *Fig. 7.* F. *linaria: lesser red pole* *Fig. 8.* F. *montana: tree sparrow.*

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to its mouth, in the same manner as a parrot.

F. chloropus, or the common water-hen, is found in various parts of England, haunting the borders of ponds and rivers, which abound in weeds, and breeding twice in a season. It flies aukwardly, but runs and swims well. Its flesh is thought excellent, and its general weight is about fifteen ounces. Rallus Carolinus, or the American water-hen, is as large as a quail. In the beginning of autumn these birds are found in Virginia in extreme abundance. From a state of perfect leanness they speedily become so fat as to be incapable of flying, and are knocked off the reeds of the marshes by the paddles of the Indians, who make pleasurable excursions in their canoes for this purpose, and in the course of one night a party will take ten or twelve hundred of them. They are extremely admired for food, and supply part of the daily repast of every planter during their short season. Rallus parzana, or the spotted gallinula, is found in Cumberland, and supposed to be migratory. It is fond of solitude, and unless in breeding time, almost always alone. Its haunts are similar to those of the common water-hen. Its nest is built in the form of a boat, and tied or fixed to reeds to prevent its being carried off by the water. Its young run as soon as they are hatched. For the great coot, see Aves, Plate VII. fig. 4.

FULIGO, in botany, a genus of the Cryptogamia Fungi class and order. Fungus with a cellular fibrous bark; the fibres penetrating in a reticulate manner through the seminal mass.

FULLER, a workman employed in the woollen manufactories, to mill, or scour, cloths, serges, and other stuffs, in order to render them more thick, compact, and durable.

Fuller's *earth*, in natural history, a soft, greyish, brown, dense, and heavy marle: when dry, it is of a greyish, ash-coloured brown, in all degrees from very pale to almost black, and it has generally something of a greenish cast: it is very hard and firm, of a compact texture, of a rough and somewhat dusty surface, that adheres slightly to the tongue: it is very soft to the touch, not staining the hands, nor breaking easily between the fingers: it has a little harshness between the teeth, and melts freely in the mouth: thrown into water, it makes no ebullition, or hissing, but swells gradually in bulk, and falls into a fine soft powder.

It is of great use in scouring cloths, stuffs, &c. imbibing all the grease and oil used in preparing, dressing, &c. of the wool. It does not effervesce with the acids: before the blow-pipe it melts with a brown spongy scoria: it consists of

Silex	51.8
Alumine	25.
Lime	3.3
Magnesia	0.7
Oxide of iron	3.7
Water	15.5
	100.0

Fuller's earth is not now in so much request in the country as it was formerly, owing to the almost general use of soap. In England it is found in beds, covered by, and resting upon, that peculiar sand-stone formation, which accompanies and serves as the foundation to chalk: its colour is yellowish grey, with a faint tinge of green. It is found in Hampshire, Bedfordshire, and in Surrey.

FULLING, the art or act of cleansing, scouring, and pressing cloths, stuffs, and stockings, to render them stronger, closer, and firmer; called also milling. The fulling of cloths and other stuffs is performed by a kind of water-mill, thence called a fulling or scouring-mill. These mills, except in what relates to the mill-stones and hopper, are much the same with corn-mills: and there are even some which serve indifferently for either use; corn being ground, and cloths fulled, by the motion of the same wheel. Whence in some places, particularly in France, the fullers are called millers; as grinding corn and milling stuffs at the same time. The method of fulling cloths and woollen stuffs with soap is this: a coloured cloth is to be laid in the usual manner in the trough of a fulling mill, without first soaking it in water, as is commonly practised in many places. To full this trough of cloth, 15 pounds of soap are required, one half of which is to be melted in two pails of river or spring water, made as hot as the hand can well bear it. This solution is to be poured by little and little upon the cloth, in proportion as it is laid in the trough; and thus it is to be fulled for at least two hours; after which it is to be taken out and stretched. This done, the cloth is immediately returned into the same

trough, without any new soap, and then fulled two hours more. Then taking it out, they wring it well, to express all the grease and filth. After the second fulling, the remainder of the soap is dissolved as in the former, and cast four different times on the cloth, remembering to take out the cloth every two hours to stretch it, and undo the plaits and wrinkles it has acquired in the trough. When they perceive it sufficiently fulled, and brought to the quality and thickness required, they scour it in water, keeping it in the trough till it is quite clean. As to white cloths, as these full more easily and in less time than coloured ones, a third part of the soap may be spared.

FULMINATION, in chemistry, differs from detonation only in degree, they are both the effects of rapid decomposition accompanied by a loud noise, either with or without flame. See GOLD, MERCURY, POWDER, SILVER.

FUMARIA, in botany, English *fumitory*, a genus of the Diadelphia Hexandria class and order. Natural order of Corydales. Papaveraceæ, Jussieu. Essential character: calyx two-leaved; corolla ringent; filaments two, membranaceous, with three anthers on each. There are fifteen species.

FUMIGATION, in medicine, a process by means of which the nitrous and other mineral acids, in a state of vapour, is dispersed through the apartments of those who lie sick of infectious fevers. This method of destroying contagion, in crowded places, was first brought into practice by Dr. Carmichael Smyth, who having given some striking proofs of its efficacy received a reward from parliament. When this fumigation is undertaken on board ships, the ports and scuttles are closed, a number of pipkins, containing hot sand, are procured, and into each is plunged a small tea-cup, containing half an ounce of sulphuric acid. As soon as the acid is properly heated an equal quantity of pulverised nitre is added, and the mixture stirred with a glass rod. The vapour resulting from the decomposition of nitre ascends, and is by the nurses conducted to every part of the apartment, which not only abates the malignity of the fever, but effectually stops the progress of infection. In a late volume of the "Annales de Chemie," we have some striking facts of the efficacy of fumigation, according to the method of M. Guyton de Morveau, who makes use of sulphuric acid, sea-salt, and manganese. It has been tried, and completely succeeded in stopping the progress of the rot among sheep: it has destroyed the putrid odours arising from meat in the worst possible state, as well as having been eminently successful in the cure of the most alarming fevers, and preventing the effects of contagion.

FUNARIA, in botany, a genus of the Cryptogamia Musci class and order. Capsule obovate; fringe double; outer, of 16 oblique wedge-form teeth, cohering at the tips; inner, a membrane divided into 16 flat teeth; veil square. There are three species.

FUNCTION, in algebra, denotes any compound quantity; and when one of the component quantities is variable it is said to be a variable function.

Functions are formed either by addition, subtraction, multiplication, division, involution, or evolution; as also by the resolution of equations. But besides these, which are called algebraical functions, there are others called transcendental, arising from the management of exponents, logarithms, &c.

FUNDS, *public*, the taxes or other public revenues appropriated to the payment of the interest or principal of the national debt. When the expedient of borrowing large sums for the public service was first adopted, it was found necessary to set apart and assign to the lender the produce of some branch of the revenue supposed to be adequate to the payment of the interest or principal, or both, according to the terms of the contract; each loan had thus a separate fund provided for it, which was usually distinguished by the date of the transaction, the rate per cent. payable, or some circumstance relating to the mode of raising the money or the purpose to which it was to be applied. These separate funds sometimes produced more than the yearly payments with which they were charged, but more frequently fell short of them, and as making good the deficiencies of some, from the surpluses of others, or from the current supplies, created much trouble and useless intricacy in the management of the public finances, it was found more convenient to combine several of the funds, and to charge the payments for which they had been set apart on the aggregate produce of the several duties. It then became necessary to give a more general denomination to the fund; and thus have been established, at different periods, the Aggregate

Fund, the South Sea Fund, the General Fund, the Sinking Fund, and the Consolidated Fund.

The Aggregate Fund was established in the year 1715, and had this name given to it, because it consisted of a great variety of taxes and surpluses of taxes, which were in that year consolidated, and given as the security for discharging the interest and principal of all the Exchequer bills then outstanding, and of some other public debts; and likewise for the payment of 120,000*l*. per annum to the civil list.

The South Sea Fund was established in 1716, and was so called because appropriated to pay the interest and allowance for management on the capital of the South Sea Company.

The General Fund was also established in 1716, by making perpetual various duties which had been granted for the term of thirty-two years, and consolidating them with some other duties into one fund. It was appropriated chiefly to the payment of the interest on various sums raised by lotteries during the reign of Queen Anne.

The Sinking Fund consisted of the surpluses of the three funds just mentioned, whenever the produce of the taxes composing them should be greater than the charges upon them. The establishment of these funds formed part of a plan for a general reduction of the interest payable on the public debts, and this being effected, the charge on each of the three funds was of course lessened considerably, and the future overplus was directed to be carried into a fourth fund, to which was given the name of the Sinking Fund, because appropriated to the purpose of redeeming or sinking the public debts. The act of parliament by which this fund was established, expressly ordained that it should be applied to the discharge of the public debts, and "to or for none other use, intent, or purpose whatsoever;" yet in the course of a few years many encroachments were made upon it, and ultimately it became a mere nominal distinction, the whole produce of it being usually taken towards the supplies of the curent year.

The Consolidated Fund was established in consequence of a new arrangement of the public accounts in the year 1786, when the funds abovementioned were abolished, and the whole of the public revenue, (except the annual grants) included under this general head. Out of this fund are paid the interest and expenses of management of all the public debts, the interest on Exchequer bills, the civil list, pensions to the royal family and others, salaries and allowances to various public officers, and some miscellaneous annual expenses. The surplus of the produce of the fund, after satisfying all these charges, is annually granted by parliament as part of the ways and means for raising the supplies voted.

Hence, it appears, that the public funds are properly the provision which has been made for payment of the interest or principal of the public debts; but as the possession of the acknowledgment given by government for the money borrowed, established a right to receive the payments from the fund on which the loan was originally charged, the sale of these securities was considered as the sale of a portion of that particular fund, and as the acknowledgments given were of different kinds, the general appellation of the provision on which they rested was found more convenient for purposes of business. Thus the sale and purchase of government securities was commonly called the sale and purchase of the public funds, till, in the course of time, the expression has so far varied from its original signification, that, instead of meaning the revenue out of which the interest of the public debts is payable, it denominates the capital of the debts, in which sense it is now commonly used. Thus, the possession of 1000*l*. in the public funds, is understood to mean 1000*l*. capital, bearing a certain rate of interest at 3, 4, or 5 per cent. per annum, according to the original terms of the loan.

The debts bearing a certain rate of interest payable till the principal shall be redeemed, are denominated, in the language of finance, perpetual annuities, or redeemable annuities, but, in the common course of business, they are called funds or stocks; a small part of the public debts consist of annuities for a certain term of years, commonly called long or short annuities: there are also some life and tontine annuities still existing; but the whole of the terminable annuities bears a very small proportion to the permanent debts. The perpetual annuities are distinguished according to the rate of interest they pay, or the time or purpose of their creation; and when by a new loan government contracts an additional debt, bearing a certain fixed interest, the capital thus created is added to the amount of that part of the public debt which bears the same rate of interest, and the produce

of the taxes imposed for payment of the interest of such new debt being carried to the fund established for paying the interest of the former capital, the old and new debts are consolidated, and the whole interest made payable out of the general produce of the fund; hence we have three or four per cent. consolidated annuities, according to the rate of interest payable on the capital.

The interest on all the public debts was formerly paid at the Exchequer; but the Bank being found a much more convenient place for this purpose, nearly the whole is now payable there, the company receiving a certain allowance from government for managing all business relative to the public funds. The different denominations of the funds transferrable at the Bank of England, with the days on which the transfers are made, and the times when the interest or dividend becomes due, are at present as follows:

Funds.	Transfer days.	Dividends due.
Consolidated 3 per Cent. Annuities	Tues. Wed. Th. and Fr.	January 5, and July 5.
Three per Cent. Annuities, 1726	Tues. and Thurs.	
Navy 5 per Cent. Annuities	Mon. Wed. and Fr.	
Bank Stock	Tues. Th. and Fr.	April 5, and Oct. 10.
Five per Cent. Annuities, 1797 and 1802	Tues. Th. and Fr.	
Four per Cent. Consolidated Annuities	Tues. Th. and Sat.	
Reduced 3 per Cent. Annuities	Tues. Wed. Th. and Fr.	
Long Annuities	Mon. Wed. and Sat.	
Imperial 3 per Cent. Annuities	Mon. Wed. and Fr.	May 1, and Nov. 1.
Imperial Annuities 25 years	Tues. Th. and Sat.	
Irish 5 per Cent. Annuities	Tues. Th. and Sat.	March 25, and Sept. 25.
Irish Terminable Annuities	Tues. Th. and Sat.	

Transferrable at the South Sea House.

South Sea Stock	Mon. Wed. and Fr.	January 5, and July 5.
New South Sea Annuities	Tues. Th. and Sat.	January 5, and July 5.
Three per Cent. Annuities, 1751	Tues. and Thurs.	
Old South Sea Annuities	Mon. Wed. and Fr.	April 5, and Oct. 10.

In these several funds, but particularly in the Consolidated 3 per Cents., which is by far the greatest in amount, much business is transacted daily both at the Bank and at the Stock Exchange, a building erected expressly for the buyers and sellers of the public funds to assemble in. Persons having occasion to invest money in the funds, usually employ a broker, who finds a seller of the stock wanted, and having agreed upon the price, delivers the particulars of the transfer to be made to a clerk in the proper office at the Bank, and fills up a receipt to be signed by the seller for the money paid. The transaction is completed in a short time, with very little trouble to the parties, and this facility of buying into or selling out of the funds induces many persons to lay out their money therein in preference to all other securities. The transfer from the seller to the buyer is made free of all expence to the parties, on all the government funds; but transfers of the funds of any company or society are liable to a duty. Transfers are made at the Bank between the hours of eleven and one o'clock; but may be made till three o'clock on payment of a small fee to the clerks.

Besides the business which arises from the continual sale and purchase of property in the funds, a species of gambling has been engrafted on the fluctuations of their current price, commonly termed stock-jobbing. This consists principally in making contracts for stock, to be fulfilled some weeks or months after, without any payment or transfer being made at the time, and generally without an intention of any transfer of stock being made at all; the object of the transaction being merely to pay or receive the difference between the current price of stock at the time of making the bargain, and the price it may be at on the day fixed for settling the account. Bargains of this nature are expressly declared by an act of 7 and 8 Geo. II. to be null and void to all intents and purposes whatsoever, and persons concerned in them are in some cases

liable to a heavy penalty; instances therefore frequently occur, in which persons who have entered into large speculations in the funds, for time, refuse to fulfil their engagements, in which case those who have trusted them have no legal remedy whatever, the settlement of debts thus incurred resting, like all debts incurred by other kinds of gaming, entirely on the honour of the party.

The dividends on the public funds were long expressly exempted from all taxes, charges, and impositions whatsoever; they have, however, in common with all other descriptions of income, been lately made subject to the property tax. See STOCKS.

FUNERAL *expenses*, in law, are allowed previous to all other debts and charges; but if the executor or administrator be extravagant, it is a species of devastation or waste of the substance of the deceased, and shall only be prejudicial to himself, and not to the creditors or legatees of the deceased. But, in strictness, no funeral expenses are allowable against a creditor, except for the shroud, coffin, ringing the bell, parson, clerk, grave-digger, and bearer's fees, but not for pall or ornaments.

FUNGUS, in surgery, denotes any spongy excrescence.

FUNGI, *mushrooms*. The name of one of the seven families, or tribes, into which all vegetables are divided by Linnæus in his "Philosophia Botanica." In the sexual system, they constitute the fourth order of the class cryptogamia. It is the name also of the fifty-eighth order of the "Fragments." These plants are rarely branched, sometimes creep, but are most commonly erect. Such as are furnished with branches have them of a light spungy substance like cork. Mushrooms differ from the fuci in that those, which, like the fuci, have their seeds contained in capsules, are not branched as that numerous class of sea-weed is. The greatest part of mushrooms have no root; some, in their stead, have a number of fibres, which, by their inosculations, frequently form a net with unequal meshes, some of which produce plants similar to their parent vegetable. The stamina in these plants are still undetermined. The seeds are either spread over the surface of the plant, or placed in cavities which are open, and resemble the open capsules of some of the fuci. In mushrooms which are branched, the seeds are frequently visible by the naked eye, and always to be distinctly observed with the assistance of a good microscope. See AGARIC, &c.

These plants, particularly the powder of the lycoperdon, puff-ball, mixed into a paste with white of egg, are very astringent, and of familiar use for stopping violent hæmorrhages. As a vegetable food they are, at best suspicious. Several fungi are rank poison. Agaric is an excrescence found upon the trunks and large branches of several trees, but chiefly upon the larch, and some oaks. It is of two sorts, the male and female; the former is yellow, hard, and woody, and used for dying black; the latter is covered with a yellow bark, and white within: it tastes sweet at first, but becomes bitter after being held a short time in the mouth. This is the sort used in medicine.

FUR, or FURR, in commerce. See FURR.

FURIA, in natural history, a genus of the Vermes Intestina class and order, having a body linear, equal, filiform, and ciliate, each side with a single row of reflected prickles, pressed close to the body: one species only is mentioned by Gmelin, *viz.* the F. infernalis, which inhabits the vast marshy plains of Bothnia and Finland, where it crawls up shrubs and sedge-grass, and being carried forwards by the wind, penetrates suddenly into the exposed parts of men and cattle, where it quickly buries itself under the skin, leaving a black point where it had entered, which is frequently succeeded by excruciating pains, inflammation, and even death. This fatal termination takes no length of time, a few hours, or a day, being sufficient for the whole process, unless the animal be almost instantly extracted by means of the knife or a milk poultice.

FURLING, in the sea-language, signifies the wrapping up and binding any sail close to the yard; which is done by hauling upon the clew lines, bunt lines, &c. which wraps the sail close together, and being bound fast to the yard, the sail is furled.

FURLING *lines*, on ship board, small lines made fast to the top-sail, top-gallant-sail, and mizen-yard-arms, to furl up the the sails by.

FURLONG, a long measure, equal to one-eighth of a mile, or forty poles. It is also used, in some law-books, for the eighth part of an acre.

FURNACES. See LABORATORY.

FURR, in commerce, signifies the skin of several wild beasts, dressed in alum with the hair on, and used as part of dress, by magistrates and others. The kinds mostly made use of, are those of the ermine, sable, castor, hare, rabbit, &c. It was not till the later ages that the furrs of beasts be-

came an article of luxury. The more refined nations of ancient times never used them; those alone who were stigmatized as barbarians were clothed in the skins of animals. During Captain Cook's last voyage to the Pacific Ocean, besides various advantages derived from it as enlarging the boundaries of science, a new source of wealth was laid open in the exchange of European commodities for furrs of the most valuable and important kind on the north-west of America. Previously to this, a similar trade had been carried on, though on a much narrower scale, in Canada. It was begun by the French almost two centuries back, and in time Montreal was the grand mart of this species of commerce. The number of Indians who resorted thither increased as the name of the Europeans was more known. Whenever the natives returned with a new supply of furrs, they usually brought with them a new and more distant tribe; thus a kind of market or fair was opened, to which the several Indian nations of the new continent resorted. Our own countrymen were not long easy without sharing in this trade, and the colony at New York soon found means to divert the stream of this great circulation. The Hudson's bay trade, carried on by a company designated as the Hudson's Bay Company, was at one time almost the only trade in this article from Great Britain; there have, however, been other persons of late years engaged in it. About twenty years ago a commercial establishment of this kind, was formed under the title of the North-West Company. It was an association of about twenty persons, agreeing among themselves to carry on the furr trade. Their capital was divided into twenty shares; of these a certain proportion was held by the people who managed the business in Canada, who were stiled agents, and paid as such independently of the profits of the trade. The articles manufactured here that are used in this traffic, are coarse woollen cloths of different kinds, blankets, arms, and ammunition, Manchester goods, all kinds of the coarser hardware, cotton, hats, and stockings.

FURRS, in heraldry, a bearing which represents the skins of certain beasts, used as well in the doubling of the mantles belonging to the coat-armour, as in the coat-armours themselves. See ERMIN, ERMINOIS, &c.

FUSANUS, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Elæagni, Jussieu. Essential character: hermaphrodite; calyx five-cleft; corolla none; stamins four; germ inferior; stigmas four; drupe: male, calyx, &c. of the former; fruit abortive. Only one species.

FUSEE, in clock work, is that conical part drawn by the spring, and about which the chain or string is wound; for the use of which see CLOCK and WATCH.

FUSIL, in heraldry, a bearing of a rhomboidal figure, longer than the lozenge, and having its upper and lower angles more acute and sharp than the other two in the middle. It is called in Latin *fusus*, a spindle, from its shape,

FUSILEERS, in military affairs, are soldiers armed like the rest of the infantry, only with shorter and lighter muskets, than those of the battalion and grenadiers. They wear caps, which are somewhat less, in point of height, than common grenadier caps. There are three regiments in the English service.

FUSION, in chemistry, the application of heat to produce the dense fluid state in bodies. See CALORIC, CHEMISTRY, GLASS, HEAT, LABORATORY.

FUSTIAN, in commerce, a kind of cotton stuff, which seems as it were whaled on one side. Right fustians should be altogether made of cotton yarn, both woof and warp; but a great many are made, of which the warp is flax, or even hemp. There are fustians made of several kinds, wide, narrow, fine, coarse; with shag or nap, and without it.

FUSTICK, in the arts, is the wood of the morus tinctoria, a tree that grows to a considerable size in the West Indies. It is much used in dyeing yellow, and produces a large quantity of colouring matter. It is not very hard, and its colour is yellow with orange veins. From a decoction, acids throw down a slight greenish yellow precipitate, which is redissolved by alkalies. Alum throws down a scanty yellow precipitate; the sulphates of iron and copper throw down yellow and brown precipitates; acetate of lead, an orange precipitate, and muriate of tin, a very copious fine yellow precipitate.

FUTTOCKS, in a ship, the timbers raised over the keel, or the encompassing timbers that make her breadth. Of these there are the first, second, third, and fourth, denominated according to their distance from the keel, those next it being called first or ground futtocks, and the others upper futtocks; those timbers being put together, make a frame-bend.

G.

G, In grammar, the seventh letter and fifth consonant of our alphabet; but in the Greek, and all the Oriental languages, it occupies the third place. It is one of the mutes, and cannot be sounded without the assistance of some vowel. Its sound is formed by shutting the teeth gently together, so as scarce to touch, by a small incurvation of the sides of the tongue upwards, with the top touching the palate, at the same time that the breath is pretty strongly pressed through the lips a little opened.

In English it has a hard and soft sound; hard, as in the word *game*, *gun*, &c.; and soft, as in the word *gesture*, *giant*, &c.; at the end of words *gh* are pronounced like *ff*, as in the words *rough*, *tough*, &c. The letter *g* is also used in many words where the sound is not perceived, as in *sign*, *reign*, &c.

As a numeral, G was anciently used to denote 400; and with a dash over it, thus, $\overline{\text{G}}$, 400,000. In music it is the character or mark of the treble cleff; and from its being placed at the head, or marking the first sound in Guido's scale, the whole scale took the name gamut.

GABEL, a word met with in old records, signifying a tax, rent, custom, or service, paid to the king, or other lord.

Gabel, according to the French duties or customs, a tax upon salt, which makes the second article in the king's revenue, and amounts to about one-fourth part of the whole revenue of the kingdom.

GABION, in fortification, is a kind of basket, made of ozier-twigs, of a cylindrical form, having different dimensions, according to what purpose it is used for. Some gabions are five or six feet high, and three feet in diameter: these serve in sieges to carry on the approaches under cover, when they come pretty near the fortification. Those used in field-works are three or four feet high, and two and a half or three feet diameter. There are also gabions about one foot high, 12 inches diameter at top, and from eight to ten at bottom, which are placed along the top of the parapet to cover the troops in firing over it, they are filled with earth.

In order to make them, some picquets, three or four feet long, are stuck into the ground, in form of a circle, and of a proper diameter, wattled together with small branches in the manner of common fences. Batteries are often made of gabions.

GAD, among miners, a small punch of iron, with a long wooden handle, used to break up the ore.

One of the miners holds this in his hand, directing the point to a proper place, while the other drives it into the vein by striking it with a sledge hammer.

Gad *fly*, or Breeze *fly*, names given to the black and yellow bodied œstrus; a fly nearly as large as the common blue flesh fly. See Œstrus.

GADUS, the *cod*, in natural history, a genus of fishes of the order Jugulares. Generic character: the head smooth; gill membrane, seven-rayed; body oblong, covered with deciduous scales; fins all covered by the common skin; more than one dorsal fin, of which the rays are unarmed; ventral fins slender and ending in a point. There are twenty-three species, of which we shall notice those which follow:

G. morhua, or the common cod, inhabits the northern seas, both of Europe and America, in innumerable shoals, and constitutes an important article of human subsistence. Its general length is from two to three feet, and its common weight from fourteen to thirty pounds. It has occasionally, however, been known to weigh upwards of seventy. Its food consists of small fish, worms, crabs, and other testaceous fishes, and its voracity is extraordinary. It is prolific in the extreme, no less than a million of eggs having been counted in a single roe. Its sound, or air-bladder, is preserved with salt, and considered as a luxury; it is also converted into a sort of isinglass, in preparing which the inhabitants of Iceland are particularly skilful. Off the coasts of Cape Breton, Novia Scotia, and New England, and, more especially, on the great sand-bank off Newfoundland, this fish is found in inexhaustible abundance; the neighbourhood of the Polar Seas, where they return to deposit their spawn, and the immense number of worms to be found in these sandy bottoms being the grand induce-

ments to their preference of these situations. They are abundant also on the southern and western coasts of Iceland, but proceed towards the south only in very diminished numbers, and are rarely seen in that direction beyond the Straights of Gibraltar. Before the discovery of Newfoundland, in 1496, Iceland was the principal scene for the cod fishery, which was speedily after that event transferred to Newfoundland, where it is conducted to such an extent, merely by the hook, baited with the herring and other small fishes, as to furnish employment for fifteen thousand British seamen, and to a more numerous portion of population at home, occupied on the various articles of munufacture, indispensable for a concern of such vast extent and importance.

C. aeglefinus, or the haddock, is distinguished from every other species by its forked tail, and by having the lower jaw longer than the upper. These fishes abound in the northern seas, and are found at particular seasons on particular coasts, to which they approach in shoals of several miles in length. On the coasts of Yorkshire they are particularly abundant in the season, which has been known to commence on the same day of the month in two successive years.

Three men will not unfrequently, during the continuance of these fishes on the coast, take three tons of them in a day; and they have been often sold to the poor for the low price of a half-penny a score. In stormy weather the haddock shelters itself in the mud of the bottom. Its general length is eighteen inches, and weight, two pounds and a half.

G. merlangus, or the whiting, is, generally, about twelve inches long, and is elegantly formed. It abounds in the northern seas, and is found in some parts of the Mediterranean. In the spring, whitings are caught on the British coasts in immense abundance, and they are considered by many as preferable for the table to every other species of the cod genus. Their favourite food consists of sprats and herrings.

G. pollachius, or the pollack, is found in the Baltic and Northern seas, and on the coast of England also in vast shoals, during the summer, at which time these fishes are so prone to catch at any thing on the surface of the water, that they may be caught only with a hook and feather. In the most boisterous and tempestuous weather they are strong enough to keep their situation, and resist the impetuosity of the waves. Their general weight is from two to four pounds.

G. merluccius, or the hake, is usually from one to two feet in length. It is found in the Mediterranean and Northern seas, and abounds on the English coast, and still more on that of Ireland; and to the poor of these countries is a considerable article of food. Being, however, a coarse fish, it is rarely seen at the tables of the opulent. They feed principally on the mackrel and herring. On the coasts of Brittany an extensive hake fishery is carried on, and almost always by night. On the coast of Waterford six men would, in the course of a single night, take a thousand of these fishes with a rod and line.

G. molva, or the ling (a word implying length) is generally from three to four feet in length, and has, occasionally, been seen of seven. These fishes are found in the depths of the North seas, and constitute a considerable article of merchandize in Great Britain itself. Great numbers are salted and preserved for home consumption, as well as for exportation, for the last of which it is required by statute, that in order to any persons being entitled to the bounty on sending them abroad, they should measure twenty-two inches, exclusively of the head. During their continuance in season, their liver is white and oily, but as they decline, these qualities proportionably diminish, and at length totally disappear.

G. lota, or the burbot, is to be met with in various parts, both of Europe and Asia, frequenting clear streams and lakes. In the Trent and Witham rivers, and in the fens of Lincolnshire, it is also highly abundant. Its food consists of almost all the smaller fishes, and also of worms and frogs. Its general weight is between two and three pounds, and it is regarded as excellent for the table. Its liver is particularly celebrated, as furnishing the most luxurious banquet.

GADOLINITE, in mineralogy, a metallic fossil, first discovered by Dr. Gadolin, from whom it is named; it is also called yttria from Ytterby, where it is found: its colour is black, passing into brownish black; it occurs massive, is shining, and its lustre is vitreous; fracture conchoidal; it is hard, scratches quartz slightly, is opaque, brittle, and of a specific gravity 4.05; it attracts the magnetic needle. When pulverized and heated with dilute nitric acid, it is converted into a yellowish-grey thick jelly. It decrepitates before the blow-pipe,

assumes a reddish white colour, and remains unfused if the fragments are not very minute; with borax it is converted into a yellow-coloured glass. A new earth to which the name of yttria has been given, has been discovered in it: according to Vauquelin it consists of

Yttria	35.
Silica	25.5
Iron	25.0
Oxide of manganese	2.0
Lime	2.0
Water and carbon	10.5
	100.0

It has been found no where but at Ytterby, in Sweden.

GÆRTNERA, in botany, in memory of Joseph Gærtner, M. D. F. R. S. a genus of the Decandria Monogynia class and order. Essential character: calyx five-parted, the leaflets having on the outside a single marginal gland; corolla five-petalled, somewhat unequal, tooth-letted, furnished with very short claws; seed vessel nearly globose, with four wings. There is but one species, *viz.* G. racemosa, a native of the East Indies, in the Circar mountains.

GAFF, in naval affairs, a sort of boom used in small ships, to extend the upper edge of the mizen, and employed for the same purpose on those sails whose foremost edges are joined to the masts by hoops or lacings, and which are usually extended by a boom below; such are the main-sails of sloops, brigs, and schooners. Gaff top-sail, is a light quadrilateral sail, the head being extended on a small gaff, which hoists on the top-mast, and the foot speading from the throat to the extent of the lower gaff.

GAGE, in the sea language. When one ship is to windward of another, she is said to have the weather-gage of her. They likewise call the number of feet that a vessel sinks in the water, the ship's gage: this they find by driving a nail into a pike near the end, and putting it down beside the rudder till the nail catch hold under it; then as many feet as the pike is under water, is the ship's gage.

Gage, among letter-founders, a piece of box, or other hard wood, variously notched; the use of which is to adjust the dimensions, slopes, &c. of the different sorts of letters.

Gage, *sliding*, a tool used by mathematical instrument makers, for measuring and setting off distances. It is also of use in letter-cutting, and making of moulds.

GAHNIA, in botany, so named in honour of Henry Gahn, a genus of the Hexandria Monogynia class and order. Essential character: glume two valved, irregular; nectary two-valved, involving the filaments; stigma dichotomous. There are two species.

GAINAGE, in old law-books, properly signifies the plough-tackle, or implements of husbandry; but is also used for the grain or crop of ploughed lands.

GALANTHUS, in botany, *snow-drop*, a genus of the Hexandria Monogynia class and order. Natural order of Spathaceæ. Narcissi, Jussieu. Essential character: petals three, concave; nectary of three small emarginate petals; stigma simple. There is but one species, *viz.* G. nivalis, snow-drop.

GALARDIA, in botany, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Corymbiferæ. Essential character: receptacle chaffy; seed crowned with the five-leaved calycle; calyx of two rows of scales, almost equal. There is only one species, *viz.* G. alternifolia.

GALAX, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx ten-leaved; corolla salver-shaped; capsule one-celled, two-valved, elastic. There is but one species, *viz.* G. aphylla.

GALAXIA, in botany, a genus of the Monadelphia Triandria class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: spathe one-valved; corolla one-petalled, six-cleft; tube capillary; stigma many-parted. There are two species, both natives of the Cape of Good Hope.

GALAXY, in astronomy. A very remarkable appearance in the heavens is that called the galaxy, or milky-way. This is a broad circle, sometimes double, but for the most part single, surrounding the whole celestial concave. We perceive also in different parts of the heavens small white spots, which appear to be of the same nature with the milky-way. These spots are called nebulæ.

With a powerful telescope, Dr. Herschel first began to survey the via lactea, and found that it completely resolved the whitish appearance into stars, which the telescope he formerly used had not power enough to do. The portion he first observed, was

that about the hand and club of Orion; and found therein an astonishing multitude of stars, whose number he endeavoured to estimate, by counting many fields, and computing from a mean of these how many might be contained in a given portion of the milky-way. In the most vacant place to be met with in that neighbourhood, he found 63 stars; other six fields contained 110, 60, 70, 90, 70, and 74 stars; a mean of all which gave 79 for the number of stars to each field; and thus he found, that by allowing 15 minutes for the diameter of his field of view, a belt of 15 degrees long and two broad, which he had often seen pass before his telescope in an hour's time, could not contain less than 50,000 stars, large enough to be distinctly numbered; besides which, he suspected twice as many more, which could be seen only now and then by faint glimpses, for want of sufficient light. The success he had within the milky-way soon induced him to turn his telescope to the nebulous parts of the heavens, of which an accurate list had been published in the "Connoisance des Temps, for 1783 and 1784." Most of these yielded to a Newtonian reflector, of 20 feet focal distance, and 12 inches aperture; which plainly discovered them to be composed of stars, or at least to contain stars, and to show every other indication of its consisting of them entirely.

"The nebulæ (says he) are arranged into strata, and run on to a great length, and some of them I have been able to pursue, and to guess pretty well at their form and direction. It is probable enough that they may surround the whole starry sphere of the heavens, not unlike the milky-way, which undoubtedly is nothing but a stratum of fixed stars: and as this latter immense starry bed is not of equal breadth or lustre in every part, nor runs on in one straight direction, but is curved, and even divided into two streams along a very considerable portion of it; we may likewise expect the greatest variety in the strata of the cluster of stars and nebulæ. One of these nebulous beds is so rich, that, in passing through a section of it in the time of only 36 minutes, I have detected no less than 31 nebulæ, all distinctly visible upon a fine blue sky. Their situation and shape, as well as condition, seem to denote the greatest variety imaginable. In another stratum, or perhaps a different branch of the former, I have often seen double and treble nebulæ variously arranged; large ones, with small seeming attendants; narrow, but much-extended lucid nebulæ or bright dashes; some of the shape of a fan, resembling an electric brush issuing from a lucid point; others of the cometic shape, with a seeming nucleus in the centre, or like cloudy stars, surrounded with a nebulous atmosphere: a different sort again, contain a nebulosity of the milky kind, like that wonderful inexplicable phenomenon about Orionis; while others shine with a fainter mottled kind of light, which denotes their being resolvable into stars.

"It is very probable that the great stratum called the milky-way, is that in which the sun is placed, though perhaps not in the very centre of its thickness. We gather this from the appearance of the galaxy, which seems to encompass the whole heavens, as it certainly must do, if the sun is within the same: for, suppose a number of stars arranged between two parallel planes, indefinitely extended every way, but at a given considerable distance from one another, and calling this a sideral stratum, an eye placed somewhere within it, will see all the stars in the direction of the planes of the stratum projected into a great circle, which will appear lucid, on account of the accumulation of the stars, while the rest of the heavens, at the sides, will only seem to be scattered over with constellations, more or less crowded, according to the distance of the planes, or number of stars, contained in the thickness or sides of the stratum."

GALBANUM, in pharmacy, is obtained from the bubon galbanum, a plant found in Africa. By cutting the plant across, a milky juice flows out, which soon hardens, and constitutes galbanum. It is brought here from the Levant, in small pieces agglutinated together; its taste is acrid, and its smell strong; the specific gravity is 1.2. It is partly soluble in water and alcohol, and when distilled, it yields about half its weight of volatile oil, which is of a blueish colour.

GALBULA, the *jacamar*, in natural history, a genus of birds of the order Picæ. Generic character: bill strait, very long, quadrangular, and pointed; nostrils situated near the base of the bill, and oval; tongue pointed and short; legs feathered before, down to the toes; feet formed for climbing. There are four species.

G. alcedo, is about the size of a lark, and is of a most elegant and brilliant plumage. It is found in the damp places of the woods of Guiana and Brazil, feeding on insects,

and is of very solitary and sequestered habits, continuing motionless on its perch during the whole night, and often also a considerable part of the day, and but rarely seen otherwise than alone. Naturalists are but imperfectly acquainted with the jacamar genus, and know nothing of its nest and eggs.

GALEGA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx with subulate teeth, nearly equal; legume with oblique streaks between the seeds. There are nineteen species.

GALENIA, in botany, a genus of the Octandria Digynia class and order. Natural order of Succulentæ. Atriplices, Jussieu. Essential character: calyx four-cleft; corolla none; capsule roundish, two-seeded. There are two species.

GALEOPSIS, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ, or Labiatæ. Essential character: corolla upper-lip notched a little, vaulted; lower has two teeth above. There are four species, with several varieties.

GALILEI, or GALILEO, in biography, a most excellent philosopher, mathematician and astronomer, was the son of a Florentine nobleman, and born at Pisa, in the year 1564. The earliest subjects of his studies were poetry, music, and drawing; but his genius soon led him to the cultivation of sublimer sciences, by his proficiency in which he has immortalised his name. His father, though a noble, possessed but a limited fortune, and was therefore desirous of educating him a physician, that he might secure greater means of independence from the profits of his profession, than he could derive from his paternal estate. With this view he entered him as a student in philosophy and medicine at the university of Pisa; but Galileo became soon dissatisfied with the obscurity of the Aristotelian system, then taught in the schools, and conceived an unconquerable dislike to medical studies.

He now betook himself to the study of the mathematics, and, without the assistance of a tutor, made a rapid progress in those sciences, commencing with Euclid, and afterwards making himself master of the works of Archimedes, and of other ancient mathematicians. When his father perceived which way his inclination tended, and that his improvement indicated uncommon talents for mathematical pursuits, he prudently suffered him to follow the natural bias of his mind without any restraint. So great was the reputation he acquired as a mathematician, that in the year 1589, the Duke of Tuscany appointed him to the mathematical chair in the University of Pisa. He discharged the duties of this appointment, for about three years, with the applause and admiration of the liberal and more enlightened; but not without exciting the jealousy and opposition of the violent Aristotelians, who, because he ventured to question some of the hypothetical maxims of their master, held him out in the odious light of a visionary and dangerous innovator. Becoming disgusted with the obstructions which their ignorance and bigotry threw in the way of his promoting just principles of science, in the year 1592 he resigned his professorship at Pisa, and accepted with pleasure of an invitation that was sent him to fill the mathematical chair in the university of Padua. In this seminary he continued for eighteen years, esteemed and cherished by the Paduans and Venetians, raising the credit of the university as a school of sound philosophy, and admired by all the learned, who had sufficient liberality and spirit to emancipate themselves from the fetters of ancient prejudices.

By degrees Tuscany felt an increasing ardour for improvement, and no sooner was it known that Galileo's patriotism inclined him to devote his services to his native country, than Cosmo II, Grand Duke, sent for him to Pisa in the year 1611, where he made him professor of mathematics, with a very considerable stipend. Afterwards he invited him to Florence, and gave him the title of principal mathematician and philosopher to his highness, continuing to him the salary annexed to his professorship, without any obligation to a residence at Pisa. With the study of mathematics, Galileo united that of physics, particularly the doctrines of mechanics and optics. Before he had settled at Padua, he had written his "Mechanics," or treatise on the benefits derived from that science, and its instruments; and also his "Balance," for finding the proportion of alloy or mixed metals. These he had introduced into his lectures at that university.

Being informed at Venice, in the year 1609, that Jansen, a Dutchman, had invented a glass, by means of which distant objects appeared as if they were near, he turned his attention to this subject, and from the imperfect accounts he had received, and

his own reflections on the nature of refraction, discovered the construction of that instrument. The next day, after he had solved the problem of its construction, he made such an instrument, and by the attention which he paid to its perfection and improvement, may justly be considered as the second inventor of the telescope. He now turned his instrument towards the heavens, and discovered unheard of wonders. He perceived the surface of the moon not to be smooth, but rough, and full of prominences and cavities. The milky way he found to be an assemblage of fixed stars invisible to the naked eye. Venus he found to vary in its phases like the moon. The figure of Saturn he observed to be oblong, and imagined that it consisted of three distinct parts, one spherical in the midst, and two lesser ones on the sides, which afterwards appeared to be only the ansæ, or extreme parts of Saturn's ring. Jupiter he saw surrounded with four moons, which in honor of the Duke de Medici he called Medicean stars, and soon perceived that by means of their frequent eclipses, geographical longitudes might be found. On the sun's disk he perceived spots, from the motion of which he inferred that the sun revolved on its axis.

It was while he was pursuing these discoveries, that he was invited to Florence, where, as we have seen, he had leisure afforded him to devote himself to his mathematical and philosophical studies, without being obliged to attend to the duties of his professorship. In a very few years, however, his tranquillity was disturbed by the ignorant and bigoted clergy, on account of the zeal which he discovered for illustrating and confirming the truth of the Copernican system. That system they maintained to be false and heretical, as being contrary to the plain and express language of the scriptures; and by their complaints against him to the Inquisition at Rome, rendered it necessary for him, in the year 1615, to appear in that city to justify himself. According to letters written from Rome, by the learned Anthony Quezenghi, Galileo did not lose his courage on this occasion, but in numerous companies of men of letters and others, defended the Copernican doctrine with a force of argument which persuaded many of its truth and reasonableness, and silenced the objections of others who would not be convinced. When he attended the Inquisition, however, he was not suffered to enter into any explanations, but was directly accused of heresy for maintaining the two propositions, that the sun is the centre of the world, and immovable by a local motion, and that the earth is not the centre of the world, nor immoveable, but moves with a diurnal motion. These propositions he was ordered by a decree of the Inquisitors to renounce, and not to defend them either in conversation or writing, or even to insinuate them into the minds of any persons whomsoever. Most accounts concur in stating, that, on this occasion, he was committed to the prison of the Holy Office, where he was confined for about five months; but according to other accounts, he was treated with greater mildness, and only threatened with imprisonment if he proved refractory. Be that as it may, he was not permitted to quit Rome until he had promised to conform himself to the decree of the Inquisition; and it is probable that his sentence would have been more severe, had not the Grand Duke of Tuscany warmly interested himself on his behalf, as well as some persons of high rank and influence at the papal court.

Galileo now returned to his studies, in which his astronomical observations, and other happy discoveries served to establish most completely and satisfactorily the truth of his obnoxious opinions. From time to time he laid before the public an account of his discoveries, with such remarks and inferences as tended to point out the natural conclusions to be drawn from them. At length, in the year 1632, he ventured to publish at Florence, his famous "Dialogues on the two greatest systems of the World, the Ptolemaic and Copernican;" in which he produced the strongest arguments in favour of both systems, without expressing a decided opinion which of them was the true one, but not without such insinuations in favour of the Copernican as sufficiently indicated its superior reasonableness and his own belief in it. These dialogues, likewise, contain some keen strokes of raillery against the Aristotelians, for their bigoted and servile attachment to every hypothesis of their master.

Scarcely had this work made its appearance before the cry of heresy was raised more loudly than ever against Galileo, and he was again cited to appear before the tribunal of the Inquisition, in the year 1633. Though now seventy years of age, he was obliged to submit to the persecuting mandate, and on his arrival at Rome was first

committed prisoner to the apartments of the Fiscal of the Holy Office. Afterwards, through the intercession of the Grand Duke, he was permitted to reside in the house of his embassador, while the process was carrying on against him. After his trial had lasted about two months, he was brought up to receive sentence in full congregation; when he was ordered, in the most solemn manner, to abjure and condemn the Copernican system, as contrary to the Scriptures, and to bind himself, by oath, no longer to teach or support it, either directly or indirectly. As a punishment for having disobeyed the former decree of the court, he was condemned to be detained in the prisons of the Holy Office during the pleasure of the Cardinal Inquisitors, and enjoined, as a saving penance, for three years to come, to repeat, once a week, the seven penetential psalms, the court reserving to themselves the power of moderating, changing, and taking away altogether, or in part, the above-mentioned punishment and penance. His Dialogues were also censured, prohibited, and ordered to be burnt at Rome.

Pope Urban VIII. who at that time sat on the Pontifical throne, lessened the rigour of his sentence, by confining him for a time to the palace and garden de Medici at Rome; after which he was sent to the archiepiscopal palace at Sienna, where the air was more favourable to his state of health; and in the course of the year, 1634, he was permitted to reside at his country-house, at Ancetri, in the vicinity of Florence.

In this place he spent the remainder of his days, visited and esteemed by the most distinguished characters in Florence, and diligently applying himself to his celestial observations. By his continual use of the telescope, however, and the injuries which his eyes received from the nocturnal air, his sight was gradually impaired, till he became entirely blind about three years before his death. This calamity he bore with a truly philosophical resignation, employing himself in constant meditation and enquiry, the result of which he intended to communicate to the world. He had digested much matter, and had begun to dictate his conceptions, when he was attacked by a distemper which terminated in his death, in 1642, when he was in the seventy-eighth year of his age.

Galileo was small in stature, but of a venerable aspect, and of a vigorous constitution. His learning was very extensive; and he possessed in a high degree, a clearness and acuteness of wit. In company he was free and affable, and full of pleasantry.

He took great delight in Architecture and Painting, and designed extremely well; and he also played on the lute with great skill and taste. Whenever he spent any of his time in the country, he took great pleasure in husbandry. From the time of Archimedes, as M. Leibnitz observes, there had been nothing done in mechanical geometry, till Galileo, who possessing an excellent judgment, and great skill in the most abstruse points of geometry, first extended the boundaries of that science, and began to reduce the resistance of solid bodies to its laws. We shall follow the example of Dr. Hutton, in giving a summary sketch of his discoveries and improvements, chiefly in the language of the judicious Colin Maclaurin. "He made the evidence of the Copernican system more sensible, when he shewed from the phases of Venus, like to the monthly phases of the moon, that Venus actually revolves about the sun. He proved the revolution of the sun on his axis, from his spots; and thence the diurnal rotation of the earth became more credible. The four satellites that attended Jupiter, in his revolution about the sun, represented, in Jupiter's lesser system, a just image of the great solar system, and rendered it more easy to conceive how the moon might attend the earth, as a satellite, in her annual revolution. By discovering hills and cavities in the moon, and spots in the sun constantly varying, he shewed that there was not so great a difference between celestial and sublunary bodies as the philosophers had vainly imagined.

"He rendered no less service to science by treating, in a clear and geometrical manner, the doctrine of motion, which has been justly called the key of nature. The rational part of mechanics had been so much neglected, that scarcely any improvement was made in it for almost 2000 years; but Galileo has given us fully the theory of equable motions, and of such as are uniformly accelerated or retarded, and of these two compounded together. He first demonstrated, that the spaces described by heavy bodies from the beginning of their descent, are as the squares of the times; and that a body, projected in any direction that is not perpendicular to the horizon, describes a parabola. These were the beginnings of the doctrine of the motion of heavy bodies, which has been since carried to so great a height by Sir Isaac Newton. In geometry, he invented the cycloid, or

trochoid, though the properties of it were afterwards chiefly demonstrated by his pupil Torricelli. He invented the simple pendulum, and made use of it in his astronomical experiments: he had also thoughts of applying it to clocks, but did not execute that design. The glory of that invention was reserved for his son Vincenzo, who made the experiment at Venice in 1649; and Huygens afterwards carried the invention to perfection. Of Galileo's invention also was the machine with which the Venetians render their laguna fluid and navigable.

"He also discovered the gravity of the air, and endeavoured to compare it with that of water; and opened several other inquiries in natural philosophy. He was not esteemed and followed by philosophers only; but was honoured by persons of the greatest distinction of all nations. Galileo had scholars worthy of so great a master, by whom the gravitation of the atmosphere was fully established, and its varying pressure accurately and conveniently measured, by the column of quicksilver of equal weight sustained by it in the barometrical tube. The elasticity of the air, by which it perpetually endeavours to expand itself, and while it admits of condensation, resists in proportion to its density, was a phenomenon of a new kind, (the common fluids having no such property), and of the utmost importance to philosophy. These principles opened a vast field of new and useful knowledge, and explained a great variety of phænomena, which had been accounted for in an absurd manner before that time. It seemed as if the air, the fluid in which men lived from the beginning, had been then first discovered. Philosophers were every where busy, enquiring into the various properties and their effects; and valuable discoveries rewarded their industry. Of the great number who distinguished themselves on this occasion, we cannot but mention Torricelli and Viviani, in Italy; Pascal, in France; Otto Guricke, in Germany; and Boyle, in England."

Galileo wrote a number of treatises, of which the principal published during his life-time: besides his "Mechanics," "Balance," and "Dialogues," already mentioned, were, "The Operations of the Compass, geometrical and military," 1606; "A Discourse, addressed to the Most Serene Cosmo II. Grand Duke of Tuscany, concerning the swimming of Bodies upon, and their submersion in, Water," 1612; "Nuncius Siderous," 1610, of which a "Continuation" or "An Essay on the History of Galileo's last Observations on Saturn, Mars, Venus, and the Sun, &c." was afterwards collected from letters between Galileo and his correspondents; "A Letter concerning the Trepidation of the Moon, lately discovered, inscribed to Alphonso Antonini, with Antonini's Answer," 1638; "A Discourse of the Solar Spots, &c. with Predictions and Ephemerides of the Medicean Planets," 1613; the famous Italian piece, entitled, "Il Saggiatore," written in defence of Guiducci's "Discourse on Comets," and containing a complete account of the physiology and astronomy of our author, printed in 1623; "A Letter to Prince Leopold of Tuscany, examining the fiftieth chapter of Licetus's Letheosphoros;" "A Letter to Christopher Greinbergerus, concerning the Montuosity of the Moon," 1611; "Mathematical Discourses and Demonstrations concerning two new Sciences, relating to Mechanics and local Motions, together with an Appendix concerning the Centre of Gravity in some Solids," 1638, &c.

The preceding articles, together with some other treatises, written either by Galileo, or by some of his disciples, in defence of his doctrines and observations, were collected and published by Menolessi, in 1656, under the title of "L'Opere de Galileo Galilei Lynceo, nobile Fiorentino," &c. in two volumes quarto. Several of these pieces were translated into English, and published by Thomas Salisbury, in his "Mathematical Collections," in two vols. folio.

A volume also of his "Letters" to several learned men, and solutions of a variety of problems, was published at Bologna, in quarto. His last disciple Vincenzo Viviani, who proved a very eminent mathematician, methodised a piece of his master's, and published it under the title of "Quinto Libro de gli Elementi d' Euclid," &c. 1674, quarto; and he also published some other pieces of Galileo, including extracts from his "Letters to a learned Frenchman," in which the author gives an account of the works which he intended to have published, and an extract of a letter to John Camillo, a mathematician of Naples, concerning the angle of contact. Many other of Galileo's writings were unfortunately lost to the world, owing to the superstition of one of his ignorant nephews; who, considering that his uncle died a prisoner of the holy office, though permitted to reside in his

own house, suspected that his papers might contain dangerous heresies, and therefore committed them to the flames.

Sir John Finch, in a letter to Thomas Salisbury, attributes the destruction of Galileo's MSS. to his widow's devotion, and the fanaticism of her confessor; but the best authorities maintain that our philosopher was never married. His son Vincenzo Galilei, who, as we have already seen, honourably supported his father's reputation, by first applying his invention of the pendulum to clock-work, was of illegitimate birth.

GALIUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, flat; seeds two, roundish. There are forty-eight species.

GALL, in the animal œconomy, the same with bile. See BILE.

GALL, in natural history, denotes any protuberance or tumour, produced by the puncture of the insects on plants and trees of different kinds. Galls are of various forms and sizes, and no less different with regard to their internal structure. Some have only one cavity, and others a number of small cells communicating with each other: some of them are as hard as the wood of the tree they grow on, whilst others are soft and spongy; the first being termed gall-nuts, and the latter berry-galls, or apple-galls.

The general history of galls is this: an insect of the fly-kind (see CYNIPS), is instructed by nature to take care for the safety of her young, by lodging her eggs in a woody substance, where they will be defended from all injuries: she for this purpose wounds the branches or leaves of a tree, and the lacerated vessels, discharging their contents, soon form tumours about the holes thus made. The hole in each of these tumours, through which the fly has made its way, may for the most part be found; and when it is not, the maggot-inhabitant or its remains, are sure to be found within, on breaking the gall. It is to be observed, however, that in those galls which contain several cells, there may be insects found in some of them, though there is a hole by which the inhabitant of another cell has escaped. Oak-galls, put in a very small quantity into a solution of vitriol in water, though but a very weak one, give it a purple or vitriol colour, which, as it grows stronger, becomes black; and on this property depends the art of making our writing-ink, as also a great deal of those of dyeing and dressing leather, and other manufactures. See INK, &c.

GALL *bladder*, called vesicula, is usually of the shape of a pear, and of the size of a small hen's egg. It is situated in the concave side of the liver, and lies upon the colon, part of which it tinges with its own colour. The use of the gall-bladder is to collect the bile, first secreted in the liver, and mixing it with its own peculiar produce to perfect it farther, to retain it together a certain time, and then to expel it.

GALL *fly*. See CYNIPS.

GALL *stone*. See CALCULI *biliary*.

GALLEON, in naval affairs, a sort of ships employed in the commerce of the West Indies. The Spaniards send annually two fleets; the one for Mexico, which they call the flota, and the other for Peru, which they call the galleons.

By a general regulation made in Spain, it has been established, that there should be twelve men of war, and five tenders, annually fitted out for the armada or galleons; eight ships of six hundred tons burden each, and three tenders, one of an hundred tons, for the island Margarita, and two of eighty each, to follow the armada: for the New Spain fleet, two ships of six hundred tons each, and two tenders of eighty each; and for the Honduras fleet, two ships of five hundred tons each: and, in case no fleet happened to sail any year, three galleons and a tender should be sent to New Spain for the plate. They were formerly appointed to sail from Cadiz, in January, that they might arrive at Porto-Bello about the middle of April, where the fair being over, they might take aboard the plate, and be at Havanna with it about the middle of June, where they were joined by the flota, that they might return to Spain with the greater safety. For this purpose, the viceroy of Peru was to take care that the plate should be at Panama by the middle of March. The plate is fifteen days removing from Potosi to Arica, eight days generally from thence by sea to Callao, and from that place to Panama twenty days, taking in by the way the plate at Paita and Truxillo. It has, however, been found by experience, that the month of September is the fittest for the fleet to sail: they are about two years in the whole voyage.

The galleons bring annually of gold about two or three millions of crowns, and the

flota one. Of silver, the galleons bring eighteen or twenty thousand crowns, and and the flota ten or twelve. Of precious stones the galleons bring quantities to an immense value; besides fine wool, leather, and Campeachy wood.

GALLERY, in fortification, a covered walk across the ditch of a town, made of strong beams, covered over head with planks, and loaded with earth: sometimes it is covered with raw hides to defend it from the artificial fires of the besieged. Its sides should be musquet proof.

Gallery *of a mine*, is a narrow passage, or branch of a mine carried on underground to a work designed to be blown up. Both the besiegers and the besieged also, carry on galleries in search of each others mines, and these sometimes meet and destroy each other.

Gallery, in ship-building, a balcony, projecting from the stern or quarter of a ship of war, or of a large merchantman: the stern-gallery is wholly at the stern of the ship, and is usually decorated with a balustrade extending from one side of the ship to the other; the fore-part is limited by a partition, in which are framed the cabin windows, and the roof of it is formed by a sort of vault termed the cove, which is frequently ornamented with sculpture. Quarter-gallery is that part which projects on each quarter, and is generally fitted up as a water closet. Ships of twenty-guns and upwards, on one deck have quarter galleries, but no stern gallery; two and three deckers have quarter galleries, with their proper conveniences, and one or two stern galleries.

GALLEY, in naval affairs, a low-built vessel, using both sails and oars, and commonly carrying only a main-mast and fore-mast, which may be struck or lowered at pleasure. Such vessels are much used in the Mediterranean.

These vessels are of a long standing, though it is probable the construction of those in modern times is very different from that formerly adopted. Galleys are of a finer and slenderer make than ships. Galley is the name also of an open boat, rowing six or eight oars, and used on the Thames by Custom-house officers, press-gangs, and also for pleasure. The same word denotes the kitchen of a ship of war, or the place where the grates are put up, fires lighted, and the victuals generally dressed.

Galley *slave*, a person condemned, in France, to work at the oar on board a galley, being chained to the deck.

GALLIC-*acid*, in chemistry, exists in nut-galls, and is obtained by boiling together for some time carbonate of barytes, and a solution of gall-nuts. This affords a bluish green liquid, which consists of a solution of gallic acid and barytes. It is now to be filtered and saturated with diluted sulphuric acid. Sulphate of barytes is deposited in the state of insoluble powder, and a colourless solution of gallic acid remains behind. This is the method given by Mr. Davy, others have been suggested by almost every practical chemist. Gallic-acid, pure, is in the form of transparent plates or octahedrons. Its taste is acid, and somewhat astringent, and when heated has rather an unpleasant aromatic odour. It is soluble in about twelve parts of cold water, and in three parts of alcohol: it is soluble in ether. It combines with alkaline bodies, making with them compounds called gallates. It occasions a precipitate when poured into solutions of glucina, yttria, and zircon in acids, which distinguishes these from the other earths, none of which are precipitated from their solutions by gallic acid. Upon the metallic solutions gallic acid acts with great energy, changing the colour, and producing precipitates in many of them. Hence it is frequently used as a re-agent to detect the presence of metallic bodies. It is composed of oxygen, carbon, and hydrogen, but the proportions of each have not been accurately ascertained.

GALLIOT, a small galley designed only for chase, carrying only one mast, and two or three pattereroes; it can both sail and row, and has sixteen or twenty oars. All the seamen on board are soldiers, and each has a musket by him on quitting his oar.

GALLON, a measure of capacity both for dry and liquid things, containing four quarts; but these quarts, and consequently the gallon itself, are different, according to the quality of the thing measured: for instance, the wine gallon contains 231 cubic inches, and holds eight pounds averdupois of pure water: the beer and ale gallons contain 282 solid inches, and holds ten pounds three ounces and a quarter averdupois, of water: and the gallon for corn, meal, &c. 272¼ cubic inches, and holds nine pounds thirteen ounces of pure water.

GALLOON, in commerce, a narrow thick kind of ferret, or lace, used to edge

or border clothes, sometimes made of wool, and at other times of gold or silver.

GALLY, in printing, a frame into which the compositor empties the lines out of his composing-stick, and in which he ties up the page when it is completed. The gally is formed of an oblong square board, with a ledge on three sides, and a grove to admit a false-bottom, called a gally-slice.

GALOPINA in botany, a genus of the Tetrandria Digynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: calyx none; corolla four-cleft; seeds two, naked. There is one species, *viz.* G. circæoides, a native of the Cape of Good Hope.

GALVANI (Lewis) a modern physiologist, who has had the honour of giving his name to a supposed new principle in nature, was born in 1737, at Bologna, where several of his relations had distinguished themselves in jurisprudence and theology. From his early youth he was much disposed to the greatest austerities of the Catholic religion, and particularly frequented a convent, the monks of which attached themselves to the solemn duty of visiting the dying. He shewed an inclination to enter into this order, but was diverted from it by one of the fraternity. Thenceforth he devoted himself to the study of medicine in its different branches. His masters were the Doctors Beccari, Jacconi, Galli, and especially the Professor Galeazzi, who received him into his house, and gave him his daughter in marriage. In 1762, he sustained with reputation an inaugural thesis "De Ossibus," and was then created public lecturer in the University of Bologna, and appointed reader in anatomy to the institute in that city. His excellent method of lecturing drew a crowd of auditors; and he employed his leisure in experiments and in the study of comparative anatomy. He made a number of curious observations on the urinary organs, and on the organ of hearing in birds, which were published in the Memoirs of the Institute. His reputation, as an anatomist and physiologist, was established in the schools of Italy, when accident gave birth to the discovery which has immortalised his name. His beloved wife, with whom he lived many years in the tenderest union, was at this time in a declining state of health. As a restorative, she made use of a soup of frogs; and some of these animals, skinned for the purpose, happened to lie upon a table in her husband's laboratory, upon which was placed an electrical machine. One of the assistants in his experiments chanced carelessly to bring the point of a scalpel near the crural nerves of a frog, lying not far from the conductor. Instantly the muscles of the limb were agitated with strong convulsions. Madame Galvani, a woman of quick understanding, and a scientific turn, was present, and, struck with the phenomenon, she immediately went to inform her husband of it. He came and repeated the experiment; and soon found that the convulsion only took place when a spark was drawn from the conductor, at the time the scalpel was in contact with the nerve. It is unnecessary in this place to mention the series of experiments by which he proceeded to investigate the law of nature, of which accident had thus given him a glimpse, for which our article Galvanism must be consulted.

In conjunction with these enquiries, his duties as a professor, and his employment as a surgeon and accoucheur, in which branches he was very eminent, gave full occupation to his industry. He drew up various memoirs upon professional topics, which have remained inedited; and regularly held learned conversations with a few literary friends, in which new works were read and commented upon. He was a man of an amiable character in private life, and possessed of great sensibility, which he had the misfortune of being called to display on the death of his wife in 1790, an event which threw him into a profound melancholy. He rarely suffered a day to pass without visiting her tomb in the nunnery of St. Catherine, and pouring out his prayers and lamentations over her remains. He was always, indeed, punctual in practising the minutest rites of his religion, the early strong impressions of which never left him, and this attachment to religion was probably the cause of steadily refusing to take the civic oath exacted by the new constitution of the Cisalpine Republic, in consequence of which he incurred the deprivation of his posts and dignities. A prey to melancholy, and reduced almost to indigence, he retired to the house of his brother James, a man of very respectable character, and there fell into a state of languor and almost imbecility. The republican governors, probably ashamed of their conduct towards such a man, passed a decree for his restoration to his professional chair and its emoluments; but it then was too late. He died on November

5, 1798, at the age of sixty, amid the tears of his friends and the public regret.

GALVANISM, this surprizing branch of philosophy has been denominated galvanism, from Galvani, an Italian professor, whose experiments led to its discovery.

In 1789, some time before he made the most important discovery, he was by accident led to the fact, of electricity having the property of exciting contractions in the muscles of animals. Stimulated by the then prevailing idea of electricity being a principle inherent in animals, which acting upon the muscular susceptibility, was the immediate cause of muscular motion, he was induced to persevere in the inquiry, during the prosecution of which, he brought to light other facts, which laid the foundation of this valuable scientific acquisition.

After having observed that common electricity, even that of lightening, produced vivid convulsions in the limbs of recently killed animals, he ascertained that metallic substances, by mere contact, under particular circumstances, excited similar commotions.

He found, that it was essential, that the forces of metals employed should be of different kinds. He applied one piece of metal to the nerve of the part, and the other to the muscle, and afterwards connected the metals, either by bringing them together, or by connecting them by an arch of a metallic substance; every time this connection was formed the convulsions took place. The diversity in the metals employed in these experiments appeared, in the very early stages of this enquiry, to be connected with their respective degrees of oxydability, the one being possessed of that property in a great degree, and the other little liable to the change. Hence zinc, and silver, or gold, was found to produce the greatest muscular contractions.

The experiments of Galvani were confirmed by many able philosophers, by whom they were repeated. Those who particularly distinguished themselves by their labours on the subject were Valli, Volta, Drs. Monro and Fowler.

Galvani had theorised upon the phenomena which he had observed to a considerable extent. He conceived, that the convulsions were produced by a disturbance of the electricity inherent in animals, which was identical with the nervous fluid, and that the metallic substances employed had not any other effect, than that of transmitting the electricity from the nerve to the muscles producing the contractions in question.

Simon Volta with much labour and ingenuity successfully opposed the hypothesis of Galvani. He had recourse to those valuable experiments made by Bennet, by which to explain the phenomena observed by Galvani. Bennet had some time before observed, when plates of different metals were brought in contact, that one of the metals transmitted a portion of its electricity to the other, each of which, when separated, being at the same time insulated, evinced signs of contrary states of electricity. When the plates, for instance, were one of copper and the other zinc; the former, while the two were in contact, gave a portion of its electricity to the latter. Hence, when they were separated, and thus presented to the electrometer, the copper exhibited signs of negative electricity, and the zinc that of positive.

On this ground it was that Volta objected to the hypothesis of Galvani, and established the more plausible idea, that the electricity was furnished by the disturbance of that fluid, arising from the contact of the different metals, and that the convulsions were excited by the stimulating effect of that active agent. It was in the investigation of this experiment, that this truly ingenious philosopher was led to the discovery of the pile, which from its inventor has been called the Voltaic pile. This apparatus consisted, in combining the effects of a number of pairs of the different metals, and by that means constituting a battery in galvanism, similar in effect to the Leyden vial in common electricity.

As silver and zinc had been found in the minor experiments to produce the greatest effect, these metals were employed by Volta in the construction of his battery. The silver plates generally consisted of coins; and the zinc plates were of the same size, being frequently cast in moulds made with the silver. The same number of pieces of cloth, pasteboard, or leather, of the same size, and steeped in solution of common salt, were also provided. The above substances were formed into a pile, in the following order: zinc, silver, wet cloth; zinc, silver, wet cloth; and so on, in the same order, till the pile became sufficiently high. If it were to be elevated to any considerable height, it was usual to support it on the sides with three pillars of glass, or varnished wood.

The pile, thus formed, was found to unite the effects of as many pairs of plates as might be employed. Previously to

this no other effect had been produced than what resulted from the energy of a single pair of plates. A pile of 50 pairs of plates, with as many corresponding pieces of wet cloth, was found to give a pretty smart shock, similar to an electric shock, every time that a communication was made between the top and bottom of the pile. It was found, however, that little or no shock was perceived, when the hands, or other parts applied, were not previously moistened. It was also observed, that the effect was increased when a larger surface was exposed to the action of the pile. If the communication were made by touching the pile with the tip of each finger merely, the effect was not perceived beyond the joint of the knuckle; but if a spoon, or other metallic substance, were grasped in moistened hands, the effect was felt up to the shoulder. If the communication be formed between any part of the face, particularly near the eyes, and another part of the body, a vivid flash of light is perceived before the eyes, corresponding with the shock. This phenomenon may be more faintly observed, by placing a piece of silver, as a shilling, between the upper lip and the gum, and laying a piece of zinc at the same time upon the tongue: upon bringing the two metals in contact, a faint flash of light is perceived. It is singular, that this light is equally vivid in the dark with the strongest light, and whether the eyes be shut or open.

Another variety of galvanic battery was also contrived by Volta. The pairs of plates were soldered to each end of a bit of wire, which was afterwards bent into an arch, so that the plates became parallel to each other. A number of glass cups were also provided, and filled with a solution of culinary salt. The glasses being arranged side by side, the metallic arcs were so placed, that the silver plate was immersed in one glass, and the zinc in another; and also that a silver and zinc plate of different arcs should be placed in each glass. This arrangement was found to be similar to the pile, the water in the cups being substituted for the disks of cloth.

Soon after the discovery of the pile, in 1800, it was communicated by Volta himself to the Royal Society, London. The first experiments made in this country upon the Voltaic pile, were made jointly by Messrs. Nicholson and Carlisle. After observing the phenomena already described by Volta, they observed an important fact which had escaped the notice of that acute philosopher. When bringing the wire from the bottom of the pile, in contact with a drop of water at the top, they observed the disengagement of some gaseous substance, which had the smell of hydrogen. Supposing this effect to arise from the decomposition of the water, they caused the ends of two brass wires, coming from the two ends of the pile, to be immersed in water, so that a portion of that liquid might be exposed between the wires. A disengagement of gas immediately took place from one of the wires, while the other became as quickly tarnished, and oxydated. The former appearance took place at the silver end of the pile, the latter at the zinc end. They ascertained that the effect would not take place when the wires were placed far asunder, and that the effect diminished gradually with the distance. They observed also, that when the tincture of litmus was used, instead of water, the liquid in the vicinity of the oxydated wire, being that connected with the zinc end, became red. When they made use of wire of platina instead of brass, they observed that the wire from the zinc end of the pile, which when of brass became oxydated, now gave out bubbles of gas, which they found to be oxygen. In short, they determined that the gases evolved were oxygen and hydrogen, and in proportions fit to constitute water. These discoveries established the chemical nature of the galvanic action in England; and they soon spread over all Europe.

The above experiments were repeated by Mr. Cruickshank, of Woolwich. He employed a glass tube filled with water, having a cork at each end, through which wires of silver were passed, the points of which were separated from each other by a stratum of the liquid. Upon the wires being communicated with the two ends of the piles, the same appearances took place which were observed by Messrs. Nicholson and Carlisle: the silver wire, however, connected with the zinc-end of the pile, became oxydated, the oxide forming a white cloud round the wire: he also, instead of water, introduced into the tube an infusion of Brazil-wood. During the galvanic action, the colour in the vicinity of the wire of the zinc-end, became very pale, while that about the wire of the silver-end of the pile, appeared of a purple colour. When a metallic solution was placed in the tube, Mr. Cruickshank observed, that, instead of hydrogen gas being evolved from the wire, which connected the silver-end of the pile,

as in the former experiments, the metal became revived.

He next caused the galvanic current to pass through solutions of the muriates of lime and soda. In these experiments, he found the oxygen evolved from the wire of the zinc-end very deficient, and a smell of oxy-muriate produced. When gold wires were employed, the gold was dissolved by the oxy-muriatic acid. Aqua ammoniæ being operated upon in a similar way, both the water and the alkali underwent decomposition, producing the gases of hydrogen, nitrogen, and oxygen.

It is to the ingenious author of the above experiments, that we are indebted for the invention of the galvanic trough, a discovery which very soon superseded the use of the pile, as being more manageable, and attended with less trouble to the operator. It consists of a wooden box, or trough, the depth and breadth of which corresponds with the size of the plates. It is of such a length, in general, as to contain fifty plates, allowing a space of about three-eighths of an inch, between each pair of plates. The spaces between the plates are formed by grooves, which are to receive the plates. The plates are first soldered together in pairs, one of copper or silver, and one of zinc. The trough being lined with a cement, formed of bees'-wax and resin, the plates, which are previously warmed, are pressed into the grooves, in such order, that the zinc-side of each compound-plate may face one way, and the copper or silver the other.

It will be easily perceived, that there is the strictest analogy between the trough and the pile, in point of arrangement. See fig. 1.

The pair of plates of zinc and silver, which, in the pile, are simply laid upon each other, are, in the trough, soldered together, and cemented into the grooves; and the cavity or cells formed by the spaces between each pair of plates, in the trough, being filled with a solution of salt or other appropriate liquid, stands in the stead of the pieces of moistened cloth, between the plates of the pile.

Several powerful troughs were soon after constructed, the effects of which were strikingly evinced in producing other phenomenon, not as yet observed. Very small wires and foils of metal being exposed in their circuit, were deflagrated with great brilliancy.

A number of galvanic experiments were made by Dr. Henry, of Manchester, in which he succeeded in decomposing the sulphuric and the nitric acids, and ammonia.

Mr. Davy, professor of chemistry at the Royal Institution, made a number of experiments, the most particular of which were those, in which he ascertained, that the dissimilarity of metals was not absolutely essential to the galvanic process. He succeeded first in exciting this energy by means of one metal, the two sides of which were separated from each other. An oxydating liquid, such as an acid, was placed on one side of the plate, and a liquid having a contrary effect on the other. He afterwards produced an effect though more faintly, by treating plates of charcoal in a similar way. Hence it would appear, from these results, that the dissimilarity of the metals was only necessary to the furnishing two surfaces of different degrees of oxydability.

Hitherto it was not generally admitted, that the fluids of galvanism, and electricity, were identical. Dr. Wollaston made a number of experiments, which seem to have completely settled this point. He succeeded in decomposing water, by means of a current from the common electric machine. This effect, which had been performed with so much facility with the galvanic apparatus, was previously not known to be able to be produced by common electricity, and had hitherto appeared the most striking difference between the two principles.

This ingenious experimentalist, made a number of other experiments, tending to throw much light on the means of exciting and appreciating galvanic phenomena. He immersed each extremity of a piece of zinc and silver in dilute muriatic or sulphuric acid. The zinc, as would be expected, immediately caused the disengagement of hydrogen gas, while no appearance took place upon the silver. As soon, however, as the two metals were made to touch each other at the opposite extremities, bubbles of hydrogen were copiously given out by the silver wire. Any other metal, capable of being acted upon by the acid, being substituted for the zinc, produced with the silver a similar effect. When gold was employed with silver, iron, or copper, in the dilute nitric acid, the same effect was produced; the gold being the same with the silver in the first experiment.

He made similar experiments, using metallic solutions instead of the dilute acid. Instead, however, of silver or gold giving out hydrogen gas, on the contact being

made, the metal in solution became reduced. Thus, when iron and silver were placed in a solution of copper, the iron immediately began to reduce the copper in solution, while the silver had not the slightest action. Upon bringing the two metals in contact, however, the silver became coated with copper. Dr. Wollaston attributes the curious phenomenon, above described, to a change of states in the electricity of the metals; and in order to confirm this idea, he attempted the same by means of common electricity, in which he succeeded to his utmost satisfaction. He supposes that the chemical affinities are so altered by the presence or absence of electricity, as to induce the anomalous appearances, which took place in the above experiments. The silver wire became coated with copper, and at the same time appeared to have the power of decomposing water.

The only mystery we observe in these experiments, is the liberation of the hydrogen in a situation where no oxygen is manifested either in the form of gas, or in any other state. Nor does the new doctrine, lately advanced by Mr. Davy, throw much light on this subject. The zinc in this experiment, is said to be positively electrified, and the copper or silver to be negative. That the zinc, on that account, attracts the oxygen of the water, and the silver the hydrogen. That the constituent parts of water are by the same law made to appear in situations where the decomposition did not take place, is very evident; hence it would appear that the hydrogen is carried by some means from the zinc to the silver. Or that the oxygen passes from the silver to the zinc, or according to Mr. Davy's hypothesis, the decomposition of the water takes place between the metals, the oxygen passing inevitably to the zinc, and the hydrogen in a similar way to the silver. To the latter there are several objections, which will appear from the following experiments.

Let a tube of three feet in length be filled with dilute muriatic acid, and corked at both ends, having a wire of zinc inserted in one end, and one of silver or platina in the other. The zinc will immediately begin to give out hydrogen, but no effect will be observed at the silver wire. Let a communication be established between the wires on the outside of the tube. The silver does not immediately give out bubbles, as was the case in the experiments of Dr. Wollaston, nor does that effect take place, till a few seconds after the contact of the metals. Can we for a moment suppose that the slight negative and positive electricity, produced by the contact of two small wires, which would not affect the most delicate electrometer, can have the power, the one of attracting oxygen, and the other hydrogen, at the distance of eighteen inches, reckoning from the middle of the tube.

If the same tube be bent in the middle to an acute angle, like the letter V, according to Mr. Davy's hypothesis, the appearance of the hydrogen at the silver wire ought to take place as soon after the contact, as with the straight tube; but what is very singular, it will not take place at all. This experiment would seem to prove, that one of the constituents of the water is carried through the whole length of the tube; and that by some law which differs from those of electricity, since the angle of the tube appeared to interrupt its passage. The interruption is still greater, even with a shorter tube, when the tube is bent in different places, forming a sort of zig-zag.

The idea that hydrogen is carried from the zinc to the copper wire, is strongly favoured by another experiment. Take the glass tube, AB, fig. 2, filled with dilute muriatic acid, having a cork at B, through which the wires, *z* and *c* are passed, *z* being a wire of zinc, and *c* a wire of platina, silver, or copper. So long as the wires remain unconnected at *z*, the platina-wire appears unchanged; but, as soon as the contact is formed, bubbles of hydrogen are first seen at *d*; they then very slowly begin to appear in the lower parts of the wire; but what is singular, the moment they begin to appear at *f*, they are also seen at *s*, and some seconds are elapsed before any bubbles are seen at *g*. If the hydrogen in the last experiment were attracted by the negative state of the platina-wire, since the metal is the best conductor, it would seem, that the point, *s*, would be the last part to have parted with its electricity; and, of course, the bubbles of hydrogen ought to have appeared the last at that point, which is contrary to fact. It therefore appears more likely that the hydrogen has been held in combination by the electricity, the latter of which is taken by the nearest metallic conductor in the circuit, leaving the hydrogen in its gaseous form: the law, however, by which it moves along the liquid, does not appear to agree with any known properties of electricity, since the hydrogen is some seconds in reaching the point *g*.

It will appear, from the above experi-

ments, that the galvanic phenomena are essentially promoted, by having two metallic surfaces so situated, that one shall be oxydated, and that the other shall be situated as near it as possible, for the purpose of receiving its electricity. We have shewn, that the current is not only interrupted by distance, but that it is essential the passage should be a direct line.

In Dr. Wollaston's experiments, when the wires were placed in a metallic solution, such as that of copper and silver, and the contact formed between the zinc and silver wires, no hydrogen was evolved by the latter, the contrary of which was the case with the dilute acid; but the metal in solution became reduced upon the silver.

There does not appear any thing mysterious in the reduction of the metal, since the hydrogen does not appear, being employed in the deoxydation of the metal. A further proof that this is the case, is, that no other metals can be reduced in this way, but such as do not decompose water. This singular process enables us to account for several facts which have hitherto appeared anomalous. If a glass plate be smeared over with a solution of nitrate of silver, and a common pin be laid in the middle of the plate, beautiful ramifications of metallic silver will soon appear, as if vegetating from the pin. If the process be examined by a magnifying glass, the ramifications of silver may be fairly seen to grow from their ends. Though the more oxydable metal, the pin, may, in the first instance, have reduced a portion of silver, it does not account for the vegetative appearance which is afterwards observed. The pin cannot reduce the silver at so great a distance from itself, which is sometimes more than an inch. In order to prove, that the agency of the oxydable metal was not essential to the reduction of the metal, the writer of this article covered one half of the plate with liquid nitrate of silver, and the other half with dilute muriatic acid, suffering the liquids to touch each other; a wire of zinc was laid in the dilute acid, and one of platina in the nitrate of silver. As soon as the opposite ends of the wires were brought in contact, beautiful ramifications of silver soon began to appear from the platina wire, but no gas was observed.

If a solution of gold be used, instead of that of silver, the platina becomes speedily gilt. The experiment producing what is called the lead-tree, cannot be accounted for in any other way: it consists in filling a bottle with a solution of acetate of lead, in the upper part of which is suspended a piece of metallic zinc: in the course of a day or two, metallic lead is observed in shining filaments, suspended from the piece of zinc. The same difficulty occurs in this, as in the last experiment: the filaments of lead constantly grow from the ends at a distance of many inches from the zinc. In order to prove that this experiment is similar to the last, that is, that the lead is reduced by the hydrogen, take a tube, A B, fig. 3, at one end of which, tie a piece of bladder so tight that the tube may hold water; let a cork be inserted at A, through which the platina wire, P p, is passed; the tube being set up right in the zinc cup, D, containing dilute muriatic acid, and a connection formed at P, the platina soon becomes covered with brilliant crystals of metallic lead: hence it would appear, that the platina had the power of reducing the lead into its metallic state, or that some substance had been transmitted through the bladder adequate to that effect. If, instead of the acetate of lead, the tube be filled with dilute acid, upon the connection being formed at P, the platina becomes covered with bubbles of hydrogen: need we, therefore, hesitate in concluding, that the lead owes its reduction to the hydrogen.

The method of whitening brass and copper, by boiling them with cream of tartar and tin, is a process of this kind; the cream of tartar, and the metallic tin, answering the purpose of the zinc and acetate of lead, in the last experiment: a portion of the tin in solution is reduced upon the copper or brass, rendering it white, by the hydrogen which is produced during the galvanic contact of the copper or brass, with the tin.

In all the experiments, the zinc wire is, during its contact with that of the platina, silver, &c. undergoing an increased oxydation, which is proportionate to the quantity of hydrogen evolved at the platina wire; since the oxygen of that, and hydrogen, both of which are derived from the water, are disposed of in the oxydation of the zinc. The hydrogen passes from the zinc to the opposite wire, with the greatest facility, through a direct liquid communication, the shorter the better. It becomes much interrupted by having to turn sharp angles, or in passing through small apertures. It passes with more or less freedom through solid bodies, when moistened with water, but does not pass at all, except when moisture is present.

Having given an account of the effects resulting from a single galvanic combination, we will next give some account of the constructions of that compound apparatus, termed Galvanic, or more properly, the Voltaic battery.

The pile of Volta, of which we have already given a slight description, is at present so little used, that we shall direct our attention more particularly to the trough, as being more convenient for experiments than the pile, and at the same time less liable to be out of order.

The wood of which the trough is formed, should be the oldest and hardest mahogany, being less liable to warp than other kinds of wood. The sides of the trough must be dove-tailed together, and the bottom ought to be grooved into the sides, and fitted-in with turpentine; perpendicular grooves must be made in the sides of the trough, for the reception of the plates, correspondent to which there must be grooves in the bottom. When the length of a trough is more than two feet, it becomes unweildy; it should not even be that length, when the size of the plates would render it too heavy to be handed about. The distance between the plates should be about three-eighths of an inch; if they are nearer together, the acid employed is too soon exhausted, and consequently, the power of the battery less lasting.

The plates should be of copper and zinc. Though silver is stronger than copper, it is not so in proportion to the price.

The zinc plates are best cut out of sheets of malleable zinc, as being cheaper, less liable to break, and may be used much thinner.

The copper may be employed so thin as six ounces to the square foot.

The plates of copper being made a little larger than the zinc, may be lapped over the edges of the latter, by which means they fit much closer to the zinc plate, without the labour of hammering the copper plates previously flat. The copper plates only require to be soldered to the upper edge of the zinc plate, since the other three edges are so secured with cement in the grooves as to preclude the necessity of soldering. The lapping over of the copper is sufficient to keep it close to the zinc plate till the plate is fastened in the trough. Previously to inserting the plates in the trough, the inside must be lined with a cement, formed of resin and bees-wax, or what is cheaper, of six parts of resin and one of lime and oil. The plates, being previously warmed, are to be pressed down into the grooves before the cement becomes quite cold. After the plates have been inserted, in such order that all the zinc surfaces shall face one way and the copper the other, the cement must be more evenly adjusted with a hot iron which will reach to the bottom of the cells; the trough being laid first on one side and then on the other for that purpose.

When the cementing process is finished, and the whole sufficiently cold, the trough must be dressed off and varnished with copal varnish where it can be had; but in lieu of that with common spirit varnish. When the varnish is dry it must be polished with rotten-stone and water.

In the above construction it is manifest that two of the surfaces are lost by being laid and soldered together. About two years ago the writer of this article had conceived the possibility of making use of both the surfaces of the copper and zinc plates at the same time. Accordingly he cemented into a trough, in the groove made for the plates of metal, plates of glass. The metal plates were formed by soldering together a plate of each, of copper and zinc, and then bending them till the plates became parallel to each other, leaving a space between the two surfaces a little wider than the thickness of the glass plates.

The cells between the glass plates being filled with the proper liquid, each of the above compound plates were made to bestride one of the glass plates, in such order that a zinc and copper plate of two different compound plates, in succession to each other, may occupy each of the cells. All the surfaces are by this contrivance exposed to the action of the liquid, and might be considered double the power of a common trough, having the same number of plates.

Little or no advantage was gained by this method. Though there are two surfaces of each metal in each of the cells, it will be evident, from several minor experiments already given, that two of the surfaces are so completely disconnected as to produce little or no effect. One of the zinc surfaces in this trough is facing the glass on one side the cell, and one of the copper surfaces is similarly situated on the other side.

The trough, therefore, which is represented in figure 1, and which has been particularly described, is, for general use, the most convenient, and in other respects, the best battery yet introduced.

The next thing to be considered, is the management of the galvanic battery. First, all of the cells of the trough must be filled, within about half an inch of the top, with a liquid, composed of water, with about one twenty-fifth part of the muriatic or the nitric acid. The plates of the trough are shorter than the depth of the trough, by about three-fourths of an inch; so that the trough may be leaned on one side in the filling, for the purpose of letting the liquid run equally into all the cells.

If a number of troughs are to be connected together, the communication must be made by arcs of metal, which are inserted into the liquid of one cell of each trough, as represented in fig. 1, at C. In making the connection, it is to be observed, that the zinc surface of one trough must correspond with the copper one of another, and the zinc of the latter with copper of a third, and so on. This arrangement may be better conceived by placing them in the same order, and to end in such a way, that all the zinc surfaces may face one way, and the copper ones the other. After all the troughs are connected together, let the two unconnected ends, at which the experiments are to be made, be as near together as possible.

A connection being now formed between the two ends, one of which we shall term the zinc end, and the other the copper end, the united energy of the whole will be transmitted through the connecting medium.

EXPERIMENTS.

The most striking and the most common experiments are those which consist in the galvanic energy upon the organs of animals. If two metallic rods, or, what is equally convenient, two silver spoons, be grasped, one in each hand, the skin of the part being previously moistened with a solution of salt, and one of the spoons be brought in contact with one end of the battery, the moment the other comes in contact with the other end of the battery, the shock is perceived. Fifty compound plates will give a shock which will be felt in the elbows. One of a hundred will be felt in the shoulders. A greater number of plates give so forcible a shock to the muscles, as to be dreaded a second time. The shock appears to depend upon the number of plates. The stun, or first impression, is much the same, whatever may be the size of the plates; at least, from the size of two inches square to that of ten; the surfaces being as four to one hundred. The effect upon the muscles, as well as upon the cuticle itself, is very different from large plates, when the series is the same. It appears, that the shock, or first impression, is as the series, which is also as the intensity of the electricity. If the shock be received from the same number of large plates, the same species of commotion is produced in the first instance, as with the small plates; but if the contact be still kept up, a continuation of the effect is perceived, which is felt through the whole arms, producing a vast tremor, attended with a sensation of warmth. If the plates be from eight to twelve inches square, this effect may be perpetually kept, while the acid in the cells is expended.

Though small plates have been recommended for medical purposes, we think large ones will be found more likely to have a good effect. If the medical advantage is to be derived from the stimulus of galvanism, the effect of a perpetual and regular current of that stimulus must certainly be preferable to the rapid transmission of a small quantity.

The galvanic shock may also be conveniently given, by immersing the hands or the feet into vessels containing a solution of salt, and bringing wires from each end of the battery into the liquid. If any other part of the body is intended to be operated upon, a sponge, moistened with salt water, fastened to a metal plate connected with one end of the battery, may be applied to the part, and the hand or foot put into a vessel of the same liquid, connected by a wire with the other end of the battery. Small bits of sponge or bits of leather may be fastened to the end of the connecting wires, and made more or less moist as the delicacy of the part may require. This contrivance is very useful in operating upon the eyes or ears.

When galvanism is used medically, it should first be applied very feebly, and the effect gradually increased, as the susceptibility of the part will admit. If the part has, from disease, become so languid and insusceptible, as not be sensible of the effect, it should be scarified, or by other means have the cuticle removed. This is sometimes the case with languid tumors, and some cases of paralysis. Though we had no great opinion of the medical agency of galvanism, we have lately heard of several very successful cases, one of which in parti-

cular was the cure of perfect loss of speech. If the naked metal of the wire, from a powerful battery, be applied to the skin, it becomes cauterized and blistered.

If the plate, covered with a moistened sponge, connected with one end of the battery, be applied to the back of the head, at the same time that the moistened fingers of one hand are slightly applied to the other end, a smarting sensation will be felt in the part, and a taste at the same time will be felt in the mouth, similar, but in a greater degree, to that occasioned by the piece of zinc, and the shilling when laid upon the tongue. This experiment succeeds the best with a small number of large plates, as much as ten inches square.

Decomposition of Water and other Bodies.

The most simple way of performing this experiment, is to bring the wires coming from each end of the battery into a vessel of water. A profusion of bubbles of gas will appear to be given out from each wire, as far as they are immersed in the liquid. The nearer the wires are brought together, so as not to touch, the more rapidly the decomposition goes on. The gas produced from the wire coming from the zinc end of the battery, if the wire be of gold or platina, is found to be oxygen gas; but if the wire be of any more oxydable metal, no gas will appear, but the wire becomes oxydated. The gas furnished by the wire from the copper end of the battery, of whatever kind of metal the wire may be, is pure hydrogen. If the immersed part of this, however, be previously oxydated, no gas will be observed for some time, the hydrogen being employed in reducing the oxide upon the surface.

Both the gases are furnished from the decomposition of the water.

An apparatus more convenient for this experiment, and at the same time fitted for collecting the gases, is shewn in fig. 4; *c g*, is a cup of glass capable of receiving the glass tube, *h*; E *c*, and *f z*, are two wires of platina, fitted into two holes perforated in the bottom of the glass cup; the tube, *h*, which is close at the top, is first filled with the water or other liquid, and the cup inverted upon it; the whole are then suddenly returned into their erect position: this apparatus is then placed in the frame, fig. 5; A B C D are four pieces of brass, united together by the pieces of glass, F and G, and supported by four legs, through which also the brass rods, H and K, are passed. It is plain, the two sides of this frame are insulated with respect to each other, at least as much as is necessary for any galvanic experiment. The part *f*, in fig. 4, being introduced into any of the holes, such as *n m*, the opposite end, F, is made to rest on the opposite brass rod, K. If the wires from the battery be now connected with the frame at H and K, the gas will instantly begin to rise from the wires, *c* and *z*, up into the tube, while the liquid descends and occupies the cup.

A number of the apparatus, such as fig. 4, may be employed at the same time; and if the different tubes are filled with different liquids, such as the various solutions of salts, and the communication of each occasionally cut off, by placing some non-conductor at E, their relative conducting powers may be ascertained.

If two tubes of smaller size be placed, one over the wire, *z*, and the other over that of *c*, the gases may be collected separately.

If the tube contains a metallic solution, such as silver, lead, or copper, the wire from the copper end of the battery will afford no gas; but the metal of the solution will be reduced. Let the glass vessel A, fig. 6, have the two tubes, *z* and *c*, ground into its two necks. At the ends, *z* and *c*, of the tubes, are tied bits of bladder, so that any liquid in the tubes may have no tendency to enter the vessel A. The vessel being previously filled with some liquid, the tubes are so inserted that no air may exist between the ends of the tubes; the tubes are also provided with two small caps of ivory or wood, through which the platina wires, *p p*, are passed, reaching the bottom so near as not to pierce the bladders. The tubes being filled with water, and the wire from the zinc-end of the battery connected with the wire of tube *z*, while that of the copper is attached to that of tube *c*, the decomposition of water will speedily commence, the wire in *z* affording oxygen gas, while that of *c* affords hydrogen gas. In a very short time, the liquid of the tube, *z*, will be found to contain muriatic acid; or rather, the oxy-muriatic; and the tube, *c*, will at the same time be found to contain a fixed alkali. If the tubes be filled with infusion of cabbage, the signs of alkali and acid are very soon observed, from the liquid of *z* becoming red, and that of *c* green. If the connection be reversed, the liquids repass to the blue colour, and if

the process be continued, that of *z* becomes green, and *c* red.

Galvanism, as a source of light and heat.

Batteries of great dimensions, such as contain from 5,000 to 10,000 square inches each, of zinc and copper surface, are capable of furnishing abundance of sensible heat and much light. If the connection between the two ends of the battery be made by a very small wire, such as the fine watch-spring wire, the wire becomes red-hot for a considerable length, and if the power of the battery be great, it becomes white-hot and ultimately fused.

Let the end of the wires of the battery be each provided with a pair of tweezers, one pair of which being insulated from the hand by covering the surface with dry cloth; place between each pair of tweezers a small bit of charcoal, made in a close vessel, from box-wood, or lignum vitæ. The moment the contact is formed between the bits of charcoal, a vivid light is produced, much more brilliant than that occasioned by burning in oxygen. If the contact be frequently severed by a sort of tremulous motion, the light may be kept up for some time.

The foils and small wires of metals are deflagrated by placing them in the current. Let one of the conducting wires be brought in contact with an iron dish, filled with mercury. Let the foil or small wires be attached to the other conducting wire, and be brought in contact with the surface of the mercury, which constantly presenting a clear surface, is very convenient in these experiments. A very brilliant effect may also be produced, by presenting the foils to the surface of a sheet of tinsel.

In inflaming oils, alcohol, &c. by galvanism, some thin metallic substance, or a small piece of charcoal, should be covered with the substance to be inflamed. The moment the contact is made, as in deflagrating the metal, the oil takes fire.

The galvanic spark, with great facility, fires a mixture of oxygen and hydrogen gases.

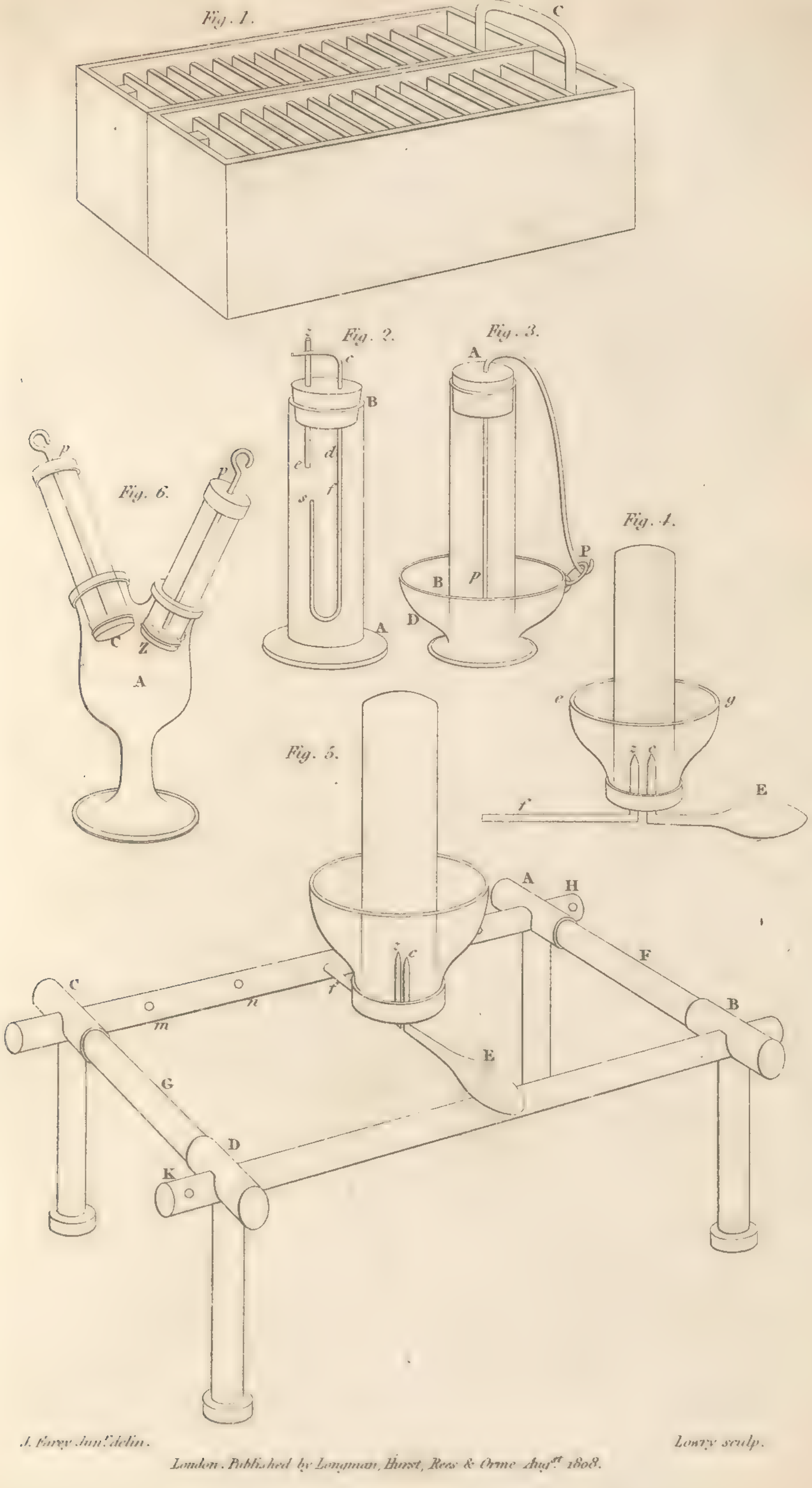
A very brilliant discovery has lately been made by Mr. Davy, Professor at the Royal Institution, and confirmed by others, which consists in the decomposition of the two fixed alkalies. It is performed by placing a bit of the alkali in the solid state, and a little moistened, upon a plate of platina, connected with one end of the battery, and bringing into contact with it another piece of platina, from the other end of the battery. A portion of black matter is soon formed, in which is found imbedded small metallic globules; which substance is found to be the base of the alkali, and has been deprived of its oxygen by the galvanic agency. These globules are so inflammable, as to decompose water, with a brilliant flash and slight explosion. See Alkali.

This discovery will be of great importance to chemistry, and will probably soon make a serious change in its arrangement and nomenclature.

GAMBOGE, is a substance obtained from the stalagmites cambogioides, a tree that grows wild in the East Indies; from which it is had by wounding the shoots. It is brought here in large cakes, which are yellow, opaque and brittle. With water it forms a yellow turbid liquid used in painting. In alcohol it is completely dissolved. If taken internally it operates violently as a cathartic.

GAME. It is a maxim of the common law, that goods of which no person can claim any property belong to the King by his prerogative: hence those animals feræ naturæ, which come under the denomination of game, are styled in our laws his Majesty's game; and that which he has he may grant to another; in consequence of which another may prescribe to have the same within such a precinct or lordship. And hence originated the right of lords of manors, or others, to the game within their respective liberties. For the preservation of these species of animals, for the recreation and amusement of persons of fortune, to whom the King has granted the same, and to prevent persons of inferior rank from misemploying their time, the following acts of parliament have been made. The common people are not injured by these restrictions, no right being taken from them which they ever enjoyed; but privileges are granted to those who have certain qualifications therein mentioned, which before rested solely in the King. To entitle any one to kill game, he must now take out a certificate, upon which a stamp duty is payable. These certificates are to be dated the day of the month when issued, and shall be in force till the first of July following, and no longer; and if any clerk of the peace, his deputy, or steward, clerk, &c. issue certificates otherwise than directed, to forfeit 20*l.* 25 Geo. III. sess. 2. No person to destroy game until he has delivered an account of his name and place of abode to the clerk of the peace, or his deputy, or

GALVANISM.



J. Farey Junr. delin. Lowry sculp.

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to the sheriff, or steward, clerk of the county, riding, shire, stewartry, or place where such person shall reside, and annually take out a certificate thereof, which must have a stamp duty of *3l.* 3s. 25 Geo. III. sess. 2. Any person counterfeiting or forging any seal or stamp directed to be used by this act, with intent to defraud the revenue, or shall utter or sell such counterfeit, on conviction thereof shall be adjudged a felon, and shall suffer death without benefit of clergy; and all provisions of former acts relative to stamp duties to be in force in executing this act. 25 Geo. III. sess. 2. Every qualified person, shooting at, killing, taking, or shooting, any pheasant, partridge, heath-fowl, or black game, or any grouse or red game, or any other game, or killing, taking, or destroying any hare, with any greyhound, hound, pointer, spaniel, setting-dog, or other dog, without having obtained such certificate, shall forfeit the sum of *20l.* *Id.* Clerks of the peace, or their deputies, or the sheriff, or steward-clerks, in their respective counties, ridings, shires, stewartries, or places, shall, on or before November 1, 1785, or sooner, if required by the commissioners of his Majesty's stamp duties, transmit to the head office of stamps in London, a correct list, in alphabetic order, of the certificates by them issued between the 25th day of March in the year 1785, and the first of October in the same year; and shall also in every subsequent year, on or before the first of August in each year, make out and transmit to the stamp office in London correct alphabetical lists of the certificates so granted by them, distinguishing the duties paid on each respective certificate so issued, and on delivery thereof, the receiver-general of the stamp duties shall pay to the clerk of the peace, &c. for the same, one halfpenny a name; and in case of neglect or refusal, or not inserting a full, true, and perfect account, he shall forfeit *20l.* *Id.* Lists may be inspected at the stamp office for 1*s.* each search; *(id.)* which lists shall once, or oftener, in every year be inserted in the newspapers in each respective county. If any qualified person, or one having a deputation, shall be found in pursuit of game, with gun, dog, or net, or other engine for the destruction of game, or taking or killing thereof, and shall be required to shew his certificate, by the lord or lady of the manor, or proprietor of the land whereon such person shall be using such gun, &c. or by any duly appointed gamekeeper, or by any qualified or certified person, or by any officer of the stamps, properly authorised by the commissioners, he shall produce his certificate: and if such person shall refuse, upon the production of the certificate of the person requiring the same, to shew the certificate granted to him for the like purpose; or in case of not having such certificate to produce, shall refuse to tell his christian and surname, and his place of residence, and the name of the county where his certificate was issued, or shall give in any false or fictitious name, he shall forfeit *50l.* *Id.* Certificates do not authorize any person to shoot at, kill, take, or destroy, any game, at any time, that is prohibited by law, nor give any person a right to shoot at, &c. unless he be duly qualified by law. *Id.* No certificate obtained under any deputation shall be pleaded or given in evidence, where any person shall shoot at, &c. any game out of the manors or lands for which it was given. The royal family are exempted from taking out certificates for themselves or their deputies. *Id.* The duty on these certificates are now, by an act which is at present passing the house, to be had through the collectors of the assessed taxes. The above is the law now in force. Besides having a certificate, each person to kill game must be qualified by having a certain estate. The last general qualification (to use the words of Dr. Burn, though in fact it is the first of the acts relative to the game ever now put in force), by estate or degree, to kill game is 22, 23 Charles II. c. 25. This enacts, that every person not having lands or tenements of the clear yearly value of 100*l.*, or on leases for 99 years, or upwards, of the clear yearly value of 150*l.*, or except the eldest son and heir of an esquire, or person of higher degree, or owners of forests, parks, &c. in respect of such forest, park, &c. is not qualified, for himself or any other person, to keep guns, bows, greyhounds, &c. s. 3. This merely states the qualification; the penalties and modes of proceeding are entirely changed by subsequent acts: and first, by 5 Ann, c. 14, which directs, that all former acts not thereby repealed and altered continue in force. With respect to offences against the game laws, we shall here enumerate those chiefly which fall under the cognizance of justices of the peace out of sessions, premising, that for brevity sake the following abbreviations are used; *viz.* P. denotes the penalty; R. the mode of recovery; A. the application of it; Ap. the appeal; J. 1 or 2, and W. 1 or 2, that one

or two justices may convict, or that one or two witnesses must prove the offence: and in treating of the several statutes on this head we shall consider, 1. what relates to game exclusively; 2. what relates to other quadrupeds; and, 3. other birds, which, though feræ naturæ, are sometimes reclaimed, and private property.

Every higler, chapman, victualler, carrier, &c. who shall have in his possession any hare, pheasant, partridge, moor-game, &c. or offer to sell any such (except sent by a person qualified to kill game), P. 5*l.* for each piece; R. distress, and in default commitment three months; J. 1. Stat. 5. Ann, c. 14, s. 2.

Persons not qualified to keep dogs, engines, &c. to destroy game, P. 5*l.*; R. as above; A. half to the informer, half to the poor. Justices, lords of manors, and gamekeepers, may take away the game, dogs, guns, &c.

Gamekeeper selling, or otherwise disposing of such game, without consent of the lord of the manor, P. three months imprisonment; conviction as above. *Ibid.* s. 4.

Killing game in the night, *i. e.* between seven in the night and six in the morning, from October 12 to February 12; and between nine at night and six in the morning, from Feb. 12 to Oct. 12; or at any time on a Sunday or Christmas Day, P. from 10*l.* to 20*l.* for the first offence, and from 20*l.* to 30*l.* for the second; conviction as above, to be within one month. 13 Geo. III. c. 80, s. 1, 2, 3, 9. In case of a third offence, P. commitment to the session, unless he become bound with two sureties to appear; prosecutor to be bound to prosecute (*ibid.* s. 1.); application of penalties, half to the informer, half to the poor; R. distress, and in default, commitment three calendar months; Ap. sessions. *Ibid.* s. 4.

More than two persons going out with guns, nets, &c. to destroy game between eight at night and six in the morning, from Oct. 1 to Feb. 1; or between ten at night and four in the morning, between Feb. 1 and Oct. 10; or any person found with fire-arms or other weapons; may be apprehended by owners, keepers, &c. who shall deliver them to a peace-officer, to be taken before a justice; or if they cannot be apprehended, the justice, on information on oath, may issue his warrant; P. deemed a rogue and vagabond, and to suffer accordingly. 39, 40 Geo. III. c. 50.

Killing, or having in possession, any partridge, between Feb. 1 and Sept. 1, or any pheasant between Feb. 1 and Oct. 1. P. 5*l.* for each bird; R. action in the courts of Westminster. 2 Geo. III. c. 19.

Killing or having in possession any black-game, from Dec. 10 to Aug. 20, (in New Forest, from Dec. 10 to Sept. 1, by 43 Geo. III. c. 34); or any red-game, from Dec. 10 to Aug. 12; or bustard, from March 1 to Sept. 1; P. 10*l.* to 20*l.* first offence, and 20*l.* to 30*l.* for every subsequent offence; R. distress and sale, if not forthwith paid, and the offender may be detained till the return of the distress, unless he gives security to appear again in five days; for want of distress, commitment from three to six calendar months, or till paid with costs; J. 1; W. 1; A. half to the informer, half to the poor; Ap. sessions, to be holden within four calendar months after the cause of complaint, giving fourteen days notice to the justice, and every other person concerned, and entering into recognizance, with one sufficient surety, to try the appeal, and abide the order of the court. 13 Geo. III. c. 55, s. 1, 2, 3, 4, 9, 10.

Every person using gun, dog, &c. to destroy the game, must take out a certificate from the clerk of the peace, for which he shall pay a duty of 3*l.* 3*s.* P. 20*l.* R. J. 1, W. 1. distress, or in default, commitment three calendar months, or till paid. A. half to the informer, half to the King. But if not prosecuted within six calendar months the whole to the king. Ap. sessions. Justice may mitigate, not to less than half and costs. Gamekeeper to take out a certificate, for which he shall pay 1*l.* 1*s.*; under the same regulations and penalties. 25 Geo. III. c. 5. 31 Geo. III. c. 21.

Killing, or attempting to kill, any deer, in any forest, chase, or park, without consent of the owner, P. 20*l.*; and for every deer killed or carried away, 30*l.*; and if the offender be a keeper, double. R. sessions. Conviction, J. 1, who shall transmit the conviction to the sessions. 16 Geo. III. c. 30, s. 1, 3. Justice, on oath W. 1, may issue his warrant to search for any deer-skin, head, &c. or any net, and cause the person on whose premises they are found to be brought before him, and if he does not give a satisfactory account how he came by them, P. from 10*l.* to 30*l.* *Ibid.* s. 4. Persons through whose hands the deer, &c. have passed, not giving a good account, liable to the same penalties. *Ibid.* s. 5. Keepers and their assistants may apprehend offenders they find in the act, and take them before a justice. *Ibid.* c. 15. R. distress,

and for want of distress, commitment for six months, or till paid, with costs. J. 1. W. 1. A. half to the King, half to the informer. *Ibid.* s. 11.

Burning furze, fern, &c. on any forest or chase, without consent of the owner, keeper, &c. P. 40*s.* to 5*l.* R. distress, or in default, commitment from one to three months. J. 1. W. 1. A. half to the informer, half to the poor. 28 Geo. II. c. 19.

Unlawfully entering into any ground (enclosed or not), and hunting or killing rabbits, P. treble damages to the party aggrieved and costs, or commitment for three months, and till he find sureties for his good behaviour. J. 1. W. 1. 22, 23 Charles II. c. 25, s. 4.

Killing or taking house-dove or pigeon, P. 20*s.* or commitment from one to three calendar months, or till paid. R. J. 1. W. 1. A. to the prosecutor, 2 Geo. III. c. 29.

Driving, or taking by nets, tunnels, &c. any water-fowl in the moulting season, P. 5*s.* for each fowl, and nets to be seized and destroyed. R. distress, and in default commitment from fourteen days to one month. J. 1. W. 1. A. half to the informer, half to the poor. 9 Ann, c. 25, s. 4.

Game, are deer, hares, pheasants, partridges, moor-game, and, by the act now passing, snipes and woodcocks are made game.

It is not to be inferred that these statutes actually impower qualified persons to hunt or shoot anywhere. They cannot enter another man's land in pursuit of game without his leave; but at the same time, if he has not warned the sportsman against coming upon his land, he will not recover more than 40*s.* costs in an action of trespass.

Sporting seasons. The time for sporting, in the day, is from one hour before sun rising, until one hour after sun setting. 10 Geo. III. c. 19. For bustards, the sporting is from Dec. 1 to March 1. For grouse, or red grouse, from Aug. 11 to Dec. 10. Hares may be killed all the year, under the restrictions in 10 Geo. III. c. 19. Heath-fowl, or black-game, from Aug. 20 to Dec. 20. Partridges, from Sept. 1 to Feb. 12. Pheasants, from Oct. 1 to Feb. 1. Widgeons, wild ducks, wild geese, wild fowls, at any time but in June, July, August, and September.

GAMING, *laws of.* These are founded on the doctrine of chances. See CHANCE.

M. de Moivre, in a treatise "De Mensura Sortis," has computed the variety of chances in several cases that occur in gaming, the laws of which may be understood by what follows:

Suppose p the number of cases in which an event may happen, and q the number of cases wherein it may not happen, both sides have the degree of probability, which is to each other as p to q.

If two gamesters, A and B, engage on this footing, that, if the cases p happen, A shall win; but, if q happen, B shall win, and the stake be a; the chance of A will be $\frac{pa}{p+q}$, and that of B $\frac{qa}{p+q}$; consequently, if they sell the expectancies, they should have that for them respectively.

If A and B play with a single die, on this condition, that, if A throw two or more aces at eight throws, he shall win; otherwise B shall win; what is the ratio of their chances? Since there is but one case wherein an ace may turn up, and five wherein it may not, let $a = 1$, and $b = 5$. And again, since there are eight throws of the die, let $n = 8$; and you will have $\overline{a+b}|^n - b^n - nab - 1$, to $b^n + nab^n - 1$: that is, the chance of A will be to that of B, as 663,991 to 10,156,525, or nearly as 2 to 3.

A and B are engaged at single quoits, and, after playing some time, A wants 4 of being up, and B 6; but B is so much the better gamester, that his chance against A upon a single throw would be as 3 to 2; what is the ratio of their chances? Since A wants 4, and B 6, the game will be ended at nine throws; therefore raise $a + b$ to the ninth power, and it will be $a^9 + 9a^8b + 36a^7bb + 84a^6b^3 + 126a^5b^4 + 126a^4b^5$, to $84a^3b^6 + 36aab^7 + 6ab^8 + b^9$: call a 3, and b 2, and you will have the ratio of chances in numbers, *viz.* 1,759,077 to 194,048.

A and B play at single quoits, and A is the best gamester, so that he can give B 2 in 3, what is the ratio of their chances at a single throw? Suppose the chances as z to 1, and raise $z + 1$ to its cube, which will be $z^3 + 3z^2 + 3z + 1$. Now since A could give B 2 out of 3, A might undertake to win three rows running; and, consequently, the chances in this case will be as z^3 to $3z^2 + 3z + 1$. Hence $z^3 = 3z^2 + 3z + 1$; or, $2z^3 = z^3 + 3z^2 + 3z + 1$. And, therefore, $z\sqrt[3]{2} = z + 1$; and, consequently, $z = \frac{1}{\sqrt[3]{2} - 1}$. The

chances, therefore, are $\frac{1}{\sqrt[3]{2}-1}$, and 1, respectively.

Again, suppose I have two wagers depending, in the first of which I have 3 to 2 the best of the lay, and in the second, 7 to 4, what is the probability I win both wagers?

1. The probability of winning the first is $\frac{3}{5}$, that is the number of chances I have to win, divided by the number of all the chances: the probability of winning the second is $\frac{7}{11}$: therefore, multiplying these two fractions together, the product will be $\frac{21}{55}$, which is the probability of winning both wagers. Now, this fraction being subtracted from 1, the remainder is $\frac{34}{55}$, which is the probability I do not win both wagers: therefore the odds against me are 34 to 21.

2. If I would know what the probability is of winning the first, and losing the second, I argue thus: the probability of winning the first is $\frac{3}{5}$, the probability of losing the second is $\frac{4}{11}$: therefore multiplying $\frac{3}{5}$ by $\frac{4}{11}$, the product $\frac{12}{55}$ will be the probability of my winning the first, and losing the second; which being subtracted from 1, there will remain $\frac{43}{55}$, which is the probability I do not win the first, and at the same time lose the second.

3. If I would know what the probability is of winning the second, and at the same time losing the first, I say thus: the probability of winning the second is $\frac{7}{11}$; the probability of losing the first is $\frac{2}{5}$; therefore multiplying these two fractions together, the product $\frac{14}{55}$ is the probability I win the second, and also lose the first.

4. If I would know what the probability is of losing both wagers, I say, the probability of losing the first is $\frac{2}{5}$, and the probability of losing the second $\frac{4}{11}$; therefore the probability of losing them both is $\frac{8}{55}$; which being subtracted from 1, there remains $\frac{47}{55}$; therefore, the odds of losing both wagers is 47 to 8.

This way of reasoning is applicable to the happening or failing of any events that may fall under consideration. Thus, if I would know what the probability is of missing an ace four times together with a die, this I consider as the failing of four different events. Now the probability of missing the first is $\frac{5}{6}$, the second is also $\frac{5}{6}$, the third $\frac{5}{6}$, and the fourth $\frac{5}{6}$; therefore the probability of missing it four times together is $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{625}{1296}$; which being subtracted from 1, there will remain $\frac{671}{1296}$ for the probability of throwing it once or oftener in four times; therefore the odds of throwing an ace in four times, is 671 to 625.

But if the flinging of an ace was undertaken in three times, the probability of missing it three times would be $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{125}{216}$: which being subtracted from 1, there will remain $\frac{91}{216}$ for the probability of throwing it once or oftener in three times; therefore the odds against throwing it in three times are 125 to 91. Again, suppose we would know the probability of throwing an ace once in four times, and no more: since the probability of throwing it the first time is $\frac{1}{6}$, and of missing it the other three times is $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6}$, it follows that the probability of throwing it the first time, and missing it the other three successive times, is $\frac{1}{6} \times \frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{125}{1296}$; but because it is possible to hit it every throw as well as the first, it follows, that the probability of throwing it once in four throws, and missing the other three, is $\frac{4 \times 125}{1296} = \frac{500}{1296}$; which being subtracted from 1, there will remain $\frac{796}{1296}$ for the probability of throwing it once, and no more, in four times: therefore, if one undertake to throw an ace once, and no more, in four times, he has 500 to 796 the worst of the lay, or 5 to 8 very near.

Suppose two events are such, that one of them has twice as many chances to come up as the other, what is the probability that the event, which has the greater number of chances to come up, does not happen twice before the other happens once, which is the case of flinging 7 with two dice before 4 once? Since the number of chances are as 2 to 1, the probability of the first happening before the second is $\frac{2}{3}$, but the probability of its happening twice before it, is but $\frac{2}{3} \times \frac{2}{3}$ or $\frac{4}{9}$; therefore it is 5 to 4 seven does not come up twice before four once.

But if it were demanded what must be the proportion of the facilities of the coming up of two events, to make that which has the most chances come up twice, before the other comes up once? The answer is 12 to 5 very nearly; whence it follows, that the probability of throwing the first before the second is $\frac{12}{17}$, and the probability of throwing it twice is $\frac{12}{17} \times \frac{12}{17}$, or $\frac{144}{289}$; therefore the probability of not doing it is $\frac{145}{289}$: therefore the odds against it are, as 145 to 144, which comes very near an equality.

Suppose there is a heap of thirteen cards of one colour, and another heap of thirteen cards of another colour, what is the

probability that, taking one card at a venture out of each heap, I shall take out the two aces?

The probability of taking the ace out of the first heap is $\frac{1}{13}$, the probability of taking the ace out of the second heap is $\frac{1}{13}$; therefore the probability of taking out both aces is $\frac{1}{13} \times \frac{1}{13} = \frac{1}{169}$, which being subtracted from 1, there will remain $\frac{168}{169}$: therefore the odds against me are 168 to 1.

In cases where the events depend on one another, the manner of arguing is somewhat altered. Thus, suppose that out of one single heap of thirteen cards of one colour I should undertake to take out first the ace; and, secondly, the two: though the probability of taking out the ace be $\frac{1}{13}$, and the probability of taking out the two be likewise $\frac{1}{13}$; yet the ace being supposed as taken out already, there will remain only twelve cards in the heap, which will make the probability of taking out the two to be $\frac{1}{12}$; therefore the probability of taking out the ace, and then the two, will be $\frac{1}{13} \times \frac{1}{12}$.

In this last question the two events have a dependence on each other, which consists in this, that one of the events being supposed as having happened, the probability of the other's happening is thereby altered. But the case is not so in the two heaps of cards.

If the events in question be n in number, and be such as have the same number a of chances by which they may happen, and likewise the same number b of chances by which they may fail, raise $a + b$ to the power n. And if A and B play together, on condition that if either one or more of the events in question happen, A shall win, and B lose, the probability of A's winning will be $\frac{\overline{a+b}|^n - b^n}{\overline{a+b}|^n}$; and that of B's winning will be $\frac{b^n}{\overline{a+b}|^n}$; for when $a + b$ is actually raised to the power n, the only term in which a does not occur is the last bn; therefore all the terms but the last are favourable to A.

Thus, if $n = 3$, raising $a + b$ to the cube $a^3 + 3\,a^2\,b + 3\,a\,b^2 + b^3$, all the terms but b^3 will be favourable to A; and therefore the probability of A's winning will be $\frac{a^3 + 3\,a^2\,b + 3\,a\,b^2}{\overline{a+b}|^3}$, or $\frac{\overline{a+b}|^3 - b^3}{\overline{a+b}|^3}$; and the probability of B's winning will be $\frac{b^3}{\overline{a+b}|^3}$. But if A and B play on condition, that if either two or more of the events in question happen, A shall win; but in case one only happen, or none, B shall win; the probability of A's winning will be $\frac{\overline{a+b}|^n - n\,a\,b^{n-1} - b^n}{\overline{a+b}|^n}$; for the only two terms in which $a\,a$ does not occur, are the two last, *viz.* $n\,a\,b^{n-1}$ and b^n. See Simpson's "Nature and Laws of Chance." We shall now add a table that may be useful to persons not skilled in mathematics, and which is applicable to many subjects:

TABLE,

Shewing the Odds of Winning in any Game, when the Number of Games wanting does not exceed Six, and the Skill of the Contenders is equal.

Games wanting.	Odds of winning.	Games wanting.	Odds of winning.	Games wanting.	Odds of winning.
1, 2	3 : 1	2, 3	11 : 5	3, 5	99 : 29
1, 3	7 : 1	2, 4	26 : 6	3, 6	219 : 37
1, 4	15 : 1	2, 5	57 : 7	4, 5	163 : 93
1, 5	31 : 1	2, 6	120 : 8	4, 6	382 : 130
1, 6	63 : 1	3, 4	42 : 22	5, 6	638 : 386

The above proportions are found by the binomial theorem in a very easy way. Suppose the games wanting 1 and 5 raise $a + b$ to the 5th power being the number of games which must determine the bet. $a = b$ in this case, as the skill is equal; $a^5 + 5,\ a^4\,b + 10,\ a^3\,b^2 + 10,\ a^2\,b^3 + 5,\ a\,b^4 + b^5$, the first five coefficients are the chances of him who has 1 game to get, *viz.* $1 + 5 + 10 + 10 + 5 = 31$, and the other, *viz.* 1 the chance of him who has five to get.

Suppose the games wanting are 2 and 5,

then $a^6 + 6, a^5 b + 15, a^4 b^2 + 20, a^3 b^3 + 15, a^2 b^4 + 6, a b^5 + b^6$, the chances for him wanting two are $1 + 6 + 15 + 20 + 15 = 57$; but for him wanting 5, are $6 + 1 = 7$ according to table 57 : 7

Suppose the games wanting 4 and 6 then $a^9 + 9, a^8 b + 36, a^7 b^2 + 84, a^6 b^3 + 126, a^5 b^4 + 126, a^4 b^5 + 84, a^3 b^6 + 36, a^4 b^7 + 9, a b^8 + b^9$; therefore for him wanting 4 games $1 + 9 + 36 + 84 + 126 + 126 = 382$, and to him wanting 6 are $84 + 36 + 9 + 1 = 130$: the odds are 382 : 130 according to table.

When the skill is not equal, or when the chances for winning is not equal: as,

1. If A and B play together and A wants 1 game of being up, and B wants 2; but the chances whereby B may win a game are double to the number of chances whereby A may win the same. Here the number of games are 2. And $a = 1$ and $b = 2 \because a^2 + 2ab + b^2$ will give the probability of each. $A = 1 + 4 = 5$ and $B = 4$ or the probabilities are $A : B :: 5 : 4$.

2. A wants 3 games of being up, B 7; the proportion of chances 3 to 5, what is the proportion of chances to win the set? here the number of games will be 9, $a = 3$ $b = 5$ therefore raise $\overline{a + b}|^9$ and the three last terms $\div$ by $\overline{a + b}|^9$ will express the chances of B, which subtracted from unity gives the chances of A: thus,

$a^9 + 9, a^8 b + 36, a^7 b + 84, a^6 b^3 + 126, a^5 b^4 + 126, a^4 b^5 + 84, a^3 b^6 + 36, a^2 b^7 + 9, a b^8 + b^9$.

$$B = \frac{\overline{5}|^9 + 27 \times \overline{5}|^8 + 324 \times \overline{5}|^7}{\overline{8}|^9} =$$

$$\frac{\overline{5}|^7 \times \overline{25 + 27.5 + 324}}{\overline{8}|^9} = \frac{37812500}{134217728}.$$

GAMMONING, among seamen, denotes several turns of rope taken round the bowsprit, and reeved through holes in knees of the head, for the greater security of the bowsprit.

GAMMUT, Gam, Gamma, or Gamma-ut, in music, a scale whereon we learn to sound the musical notes, *ut*, *re*, *mi*, *fa*, *sol*, *la*, in their several orders and dispositions.

GANG, in sea affairs, a select number of a ship's crew appointed on any particular service, and commanded by an officer suitable to the occasion.

Gang *board* is a plank with several steps nailed to it, for the convenience of walking into, or out of a boat upon the shore, where the water is not deep enough to float the boat close to the landing place.

Gang *way*, a narrow platform, or range of planks, laid horizontally along the upper part of a ship's side, from the quarter-deck to the forecastle, and is peculiar to ships that are deep waisted, for the convenience of walking more expeditiously fore and aft than by descending into the waist: it is fenced on the outside by iron stanchions, and ropes or rails, and in vessels of war with a netting, in which part of the hammocks are stowed. In merchant-men it is frequently called the gang-board. The same term is applied to that part of a ship's-side, both within and without, by which persons enter and depart; it is provided with steps nailed upon the ship's-side, nearly as low as the surface of the water, and sometimes furnished with a railed accomodation ladder.

GANTLOPE, in sea affairs, commonly pronounced gantlet, is a race which a criminal is sentenced to run in a vessel of war for felony, or some other heinous offence. The whole ship's crew is disposed in two rows, standing face to face on both sides the deck, each person being furnished with a small twisted cord, having two or three knots in it; the delinquent is then stripped naked above the waist, and obliged to pass forward between the two rows, a certain number of times, rarely exceeding three, during which, every person is enjoined to give him stripes as he runs along: this is called "running the gantlet," and is seldom inflicted but for crimes which excite general antipathy among the seamen.

GAOL, gaols cannot now be erected by any less authority than an act of parliament. All prisons and gaols belong to the King, although a subject may have the custody, or keeping of them. The justices of the peace at their general quarter-sessions, or the major part of them, not less than seven, upon presentment made by the grand jury at the assizes, of the insufficiency, inconveniency, or want of repair of the gaol, may contract for the building, repairing, or enlarging it, &c. or for erecting any new gaol within any distance not exceeding two miles from the scite, and in that case for selling the old gaol and its scite, the contractors giving security to the clerk of the peace for the performance of the contract. 24 George III. c. 54. The expences to be paid out of, and in certain cases, money may be raised by mortgage upon the county-rate.

As there are several persons confined in the county and city gaols, under sentence,

and orders made by one or more justices at their sessions, or otherwise, upon conviction in a summary way, without the intervention of a jury; it is by 24 George III. c. 56, enacted that any judge of assize, or two justices, within whose jurisdiction such gaol is situate, may remove such persons to any house of correction within the same jurisdiction, there to be confined, and to remain in execution of such sentence or order.

For the relief of prisoners in gaols, justices of the peace, in sessions, have power to tax every parish in the county, not exceeding 6*s.* and 8*d.* per week, leviable by constables, and distributed by collectors, &c. 12 Charles II. c. 29. But it is observed by Lord Coke, that the gaoler cannot refuse the prisoner victuals, for he ought not to suffer him to die for want of sustenance. If any subject of this realm shall be committed to any prison, for any criminal, or supposed criminal matter, he shall not be removed from thence, unless it be by habeas corpus, or some other legal writ; or where he is removed from one prison, or place to another, within the same county, in order to his trial or discharge; or in case of sudden fire, or infection, or other necessity; on pain that the person signing any warrant for such removal, and he who executes the same, shall forfeit to the party grieved, 100*l.* for the first offence, and 200*l.* for the second. Justices at sessions make regulations for the gaols of the county, and there are statutes forbidding the selling of spirits, or secretly conveying them into gaols.

Gaol *delivery*, by the law of the land, that men might not be long detained in prison, but might receive full and speedy justice, commissions of gaol delivery are issued out, directed to two of the judges, and the clerk of assize associated; by virtue of which commission, they have power to try every prisoner in the gaol, committed for any offence whatsoever. This is one of the commissions by which the judges sit at every assize.

It is a frequent question, what can be given in evidence by the defendant upon this plea, and the difficulty is to know, when the matter of defence may be urged upon the general issue, or must be specially pleaded upon the record. In many cases for the protection of justices, constables, excise officers, &c. they are by act of parliament, enabled to plead the general issue, and give the special matter for their justification under the act in evidence.

GARBOARD *strake*, the plank next the keel of a ship, one edge of which is run into the rabbit made in the upper edge of the keel on each side.

GARCINIA, in botany, so named in honour of Laurent Garcin, M. D. F. R. S. a genus of the Dodecandria Monogynia class and order. Natural order of Bicornes, Linnæus. Guttiferæ, Jussieu. Essential character: calyx four-leaved, inferior; petals four; berry eight-seeded, crowned with the peltate stigma. There are three species.

GARDANT, or Guardant, in heraldry, denotes any beast full faced, and looking right forward.

GARDEN. We must divide this article under four heads; *viz.* the flower, or pleasure garden, the kitchen garden, the nursery, and the forcing department. Of these we shall treat distinctly under the head of Gardening.

In this place it is proper to state, that a garden should have a favourable aspect, gently declining towards the south-west, and should be enclosed by a substantial wall, high to the north and to the east, but rather low towards the south and west: the former will preserve the plants from the chilling winds proceeding from those quarters, the latter will allow the genial breezes from the favourable points to circulate freely throughout the enclosure, while the sun will not be debarred during the cooler months, especially from visiting the interior in general. In the height of summer, as the sun rises and sets to the northward, the southern borders of the garden will be screened during the heat of the day, but will during the early and late hours of its stay above the horizon, receive sufficient warmth without being scorched. Hence the south side, generally speaking, affords a shady border.

The soil of a garden should be deep, rich, and clean: without such qualities the produce will be inferior, while the labour and expense will be enhanced in exact ratio with the defect. Nor can a garden be too abundantly supplied with water; the absence of which, in adequate proportion, will render every effort towards perfection totally unavailing.

It is of the utmost importance that the whole garden should have a free access of air, and that the subsoil should be wholesome and sound. The great exhaustion occasioned by constant cropping, demands liberal supplies of rich manure, that the

soil should be kept in excellent heart. Nor should such parts as are intended for the production of vegetables be crowded with trees, or bushes. We should advise in the strongest manner, that such trees, &c. as spread their roots widely, be interdicted altogether, and that such as may be considered as really indispensable be set out at ample distances, and not allowed to overshadow the beds.

It is possible, however, to have the soil of a garden made too rich, that is, for the production of vegetables in general, many of which require an open free soil, not too highly dressed. Carrots, parsnips, and even turnips may be injured by over-richness; while onions, mushrooms, asparagus, &c. delight in such parts as are manured even to a degree of rottenness.

The directions given under the head Gardening will furnish ample instruction on this subject; and will give, in a concise form, the leading features of the art, in such manner as may prove useful to, and be easily retained in memory by, those who may not be provided with publications treating abstractedly on that subject.

GARDENIA, in botany, so named in honour of Alexander Garden, M. D. of Charlestown, in Carolina, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, contorted or twisted; stigma lobed; berry inferior, two to four celled, many-seeded. There are fifteen species.

GARDENING being a science of the utmost importance to the community at large, is followed by many persons with considerable advantage to themselves. Indeed what is called market-gardening is a medium between private horticulture and that part of farming which relates to the production of green crops. We shall in this confine ourselves to horticulture as suited to ornament, and to the management of grounds cultivated with the view to family supply. The following list of fruits is usually resorted to, when forming a garden. Apples in all their varieties, pears ditto, plumbs ditto, peaches ditto, apricots ditto, nectarines ditto, cherries ditto, figs ditto, grapes ditto, mulberries ditto, medlars, quinces, walnuts, chesnuts, filberds, gooseberries, currants, raspberries, strawberries. The vegetable department usually consists of the following: asparagus, artichokes, ditto Jerusalem, beans, peas, kidney-beans, running ditto, turnips, cauliflowers, cabbages, brocoli, coleworts, sea kale, cucumbers, onions, leeks, radishes, lettuces, celery, endive, spinach, beet, parsley, fennel, cardoons, cress, mustard, chevril, potatoes, carrots, parsnips, melons, mushrooms, and love-apples; with capsicums, hyssop, marjoram, sage, mint, thyme, balm, lavender, rosemary, basil, clary, borage, and penny-royal, for pot-herbs, &c.

The flower tribe are as follow: First class, or tender annuals: amaranthus of sorts, stiamonium, egg-plant, balsams, ice-plant, sensitive plant, humble plant, scarlet convolvolus, snake-melon, and martynia.

Second class, or less tender annuals. African marigold, French ditto, aster of sorts, chrysanthemum, sweet sultan, Indian pink, palma-christi, tobacco, love-apple, gourds, persicaria, Indian corn, mignonette, convolvolus, capsicum, basil, lennia, stocks, tree-amaranthus, carmacorus, Chinese hollyhock.

The third class or hardy annuals. Adonis, larkspur, lupin, sun-flower, lavatera, convolvulus major, starry-scabius, hawkweed, carthamus, nasturtium, Tangier-pea, honey-wort, nigella, catch-fly, lychnis, navelwort, Virginia stock, pansies, snail-plant, cyanus, xeranthemum, garden marigold, purple ragwort, dracocephalum, bastard fumitory, amythysten.

The hardy biennial and perennial flowers are these: Aster, Tripolian, dog's bane, arum, asclepius, astragalus, alysson, bachelor's button, borage, ragged-robin, campanula, Canterbury-bells, caltha, cassia, carnations, pinks, sweet-william, wall flowers, stock July flowers, French honey-suckle, tree primrose, lichnidea, cyanus, lichnis, rose campion, hepatica, linaria, bee larkspur, fraxinella, gentiana, fox-glove, globularia, cyclamen, chelone, gold-locks, lily of the valley, Solomon's seal, filapendula, columbines, ibalictrum, pulsatilla orebus, vesovian, golden rod, valerian, rudbekia, pulmonaria, monarda, jacea, ephemeron, primrose, polyanthus, auricula, violet, London pride, day-lily, aconite, hellebore, geranium, daisies, ranunculus, peony, silphium, iris, cardinal, rocket, scabius, eringo, angelica, asphodel, ononis, lupins, eupetorium, balm of Gilead, moth mullien, snap-dragon, and Tradescantia.

The bulbous and tuberous kinds are, amaryllis, crocus-vernus, snow-drop, ornithogalum, erithronium, muscaria, fritillaria, crown imperials, tulip, gladiolus, anemone, ranunculus, pancratium moly, fumaria-bulbosa, Narcissus, jonquil, lily, squill, asphodel, tu-

berose, iris, hyacinth, leontice, colchicum, cyclamen, corona-regalis, aconite, and sisyrinchium.

Plants suited to the hot-house are, Aloes, arums, ambrosia, anthyllis, aretotis, aster, (African) apocynum, apium, asparagus (shrubby), bosea, campanula, buphthalmum, chysocoma, convolvolus (silvery), celastrus, Cliffortia, caper, cistus, chamomile (Italian), cyclamen, coronilla, crassula, cytisus, digitalis, diosura, iris-uvaria, euphorbia, geranium, guaphalium, grewia, heliotropium, hyperium, Hermania, jasmine, ixia, justicia, leonurus, kiggellaria, lemon, orange, citron, candy-tuft, dotus, lycium, lentiscus, lavatera, Malabar-nut, mesembryanthemum, myrtle, oleander, olive, opuntia, osteospermum, ononis, physica, phyfalis, sage (African), silver-tree, scabius, semper-vivum, sideroxylum, sedum, solanum, arvonum-Plinii, pomum-amoris, stapelin, tetragonia, tucrium, tree-germander, and tanacetum-frutescens.

The trees and shrubs designed for the ornament of pleasure grounds, &c. are either evergreens, which retain their foliage, or deciduous, which shed their leaves usually on the approach of winter.

The list of evergreens comprises arbor vitæ, arbutus, cedar, cork, cypress, fir, pine, holly, magnolia, laurel, oak, yew, alaternus, cistus, coronilla, enonymus, juniper, hartwort, horse-tail, kalma, honey-suckle, laurustinus, bay, spurge, knee-holm, phillyrea, privet, purslane (tree), phlomis, rose (evergreen), rhododendron, savin, stone-crop, (shrub), widow-wail, groundsel (of Virginia), germander, jasmine (Italian) lotus, pyracantha, medicago, bignonia, tutsan, ragwort (sea), wormwood, ivy, and furze.

The deciduous are, acacia, ash, cratægus, maple, hornbeam, medlar, chesnut, walnut, hiccory, birch, beech, sycamore, plane, larch, laburnum, liquid-amber, lac, lime, cypress, catipha, poplar, arbor-Judæ, alder willow, elm, hamamelis, service, oak, tacamabacca, persamen plumb, agnus-casters, almond, althæa-frutex, Andromeda, Arabia, azelea, berberry, bladder-nut, broom, cephalanthus, bramble, viburnum, noleosia, tupelo, empatrum, licium, chionanthus, laurustinus (African), xanthoxylium, melia, lavender, gale, spiræa, scorpionsena, smilax, syringa, sumach, toxicodendron, tamarisk, sassafras, pistachia, filberd, hazel, jesuit's bark, honey-suckle, frangula, jasmine, hydrangia, hypericum-frutex, lilac, silver-ivy, Robinia, Louisera, St. Peter's wort, mezereon, kidney-bean-tree, tallow-tree, barba-jovis, mevispernum, oleaster, peach, privet (common), palmirus, privos, periploca, flamula-jovis, itea, ptelen, cherry, rhamus, raspberry, myrtle, coccigria, cinquefoil shrub, colutea, clathea, bush-cassiberry, bignonia, Benjamin, euonymus, dogwood, Guelder rose, thorns (black and white), azerole, Naples medlar, mespilus, celtis, pear, bastaria, bird-cherry, tulip-tree, rose, briar, pomegranate, currant, gooseberry.

Those plants which are reared in green or hot-houses, and are raised from seed, as well as a great variety of tender annuals, are generally produced from hot-beds, made by collecting fresh stable dung, or tanner's bark, while capable of affording a great degree of heat. Over these beds, which are sometimes framed in with wood-work or masonry, fine soil is laid to the depth of four, five, or six inches, or in some cases more, and glass frames are fitted as covers, in such manner as to open to any desired extent. When the first heat has subsided, and the temperature is such as not to scorch, the seeds of melons, cucumbers, &c. may be sown, or the pots containing curious plants may be partly buried, so as to obtain a greater degree of heat than is afforded by the air without the frame. In this manner the most tender exotics may be propagated; indeed many become gradually so inured to our climate, as to be perfectly habituated; and after fifteen or twenty generations (or seasons, if not very perishable) may in some instances be treated the same as our tender indigenous plants. Such, however, as are not disposed so to assimilate, must be preserved in green-houses, or eventually be kept in hot-houses during the cold months; being there confined in an artificial atmosphere, highly rarified by means of a fire which warms a variety of flues that every where intersect the walls of the building. (See HOT-HOUSE.)

Having said thus much, in general terms, regarding the trees, shrubs, and vegetables, ordinarily appropriated to gardens and pleasure-grounds, we shall give the reader a brief code of instruction as to the seasons and modes appropriate to each individually, arranging the whole in form of a calendar.

JANUARY.

Kitchen-garden. Make up your hot-beds for melons, cucumbers, &c.; for early produce select the romana and cantaloupe melons, and the early prickly cucumber.

The plants will rise in a week, but you should never keep them so hot as to steam the glasses. Sow successively, in case of accidents, to which this class are very subject. If the beds cool too much, lay fresh litter all around them; or, if practicable, rake out some of the old litter, and fill up with very fresh dung; avoiding much pressure. The outside dressing will require to be changed every fortnight, as the heat will in that time be greatly abated. When the plants have made two good shoots, exclusive of their first leaves, you may remove the pots, in which they were sown, to a larger bed, where they are to remain, stripping off such shoots just beyond their second joints. In such beds you may force asparagus, lettuce, small salading, love apples, radishes, and an infinite variety of vegetables for early use: this will, however, require extensive and numerous beds.

You may in this month, if the weather be mild, sow parsley, beans, and peas, spinach, carrots, &c. but do not depend on their succeeding: they should all be sown on warm borders. Plant out cabbages for summer use, and in all the varieties for seed. For this latter purpose you may keel in any old stems that have good sprouts on them, they will furnish excellent seed, plant them in an open part, in a deep, well-worked soil, highly manured; your cauliflower-plants that stand under glasses, should be clean picked from all decayed leaves, and be well weeded; give them air occasionally during mid-day, when the sun is out; but close up well at night, so as to shut out the frost; if intensely cold, cover with matting, straw, &c.; earth your celery up well in dry, open weather, breaking the earth very small, and applying it gently; remove all the rotten tops, by twisting them off very carefully; your endive should also be picked, and tied up, in fair weather. If the plants appear wet, and injured in the heart, take them up, and, after hanging for two or three days, by their roots, to drain, transplant them into clean, well-prepared beds, earthing them up half way of their leaves, but taking care that no soil be admitted within them. Artichokes should be attended to, and well landed up; also be supplied with long litter to preserve them from frost; cover your mushroom-beds well for the same reason.

In the Fruit-garden, finish the pruning of your apple and pear trees, training all the shoots that are to remain, at full six inches asunder; you must also prune and nail your plum and cherry trees, as well as your peaches, apricots, and nectarines, provided the weather is mild, else it were better deferred to a more favourable time; however, you need not be apprehensive from slight frosts. Always loosen the whole tree before you begin to prune, so that you may remedy any defects, and be enabled to make a more perfect arrangement, cutting out all useless wood. You may prune vines when the weather permits, keeping only the shoots of the last season, no others being bearers. Gooseberries and currants must be trimmed with a bold hand, to allow free access of sun and air; keep only the wood of one, or two years. Raspberries must be looked to, cutting away all but the young shoots; these should be shortened about one-third of their length. You may now set out the cuttings from gooseberries and currants, and the young shoots of raspberries; plant at least four feet asunder every way, else your fruit will be small, and deficient in flavour; choose an open situation and a free soil.

You must now prepare ground for plantations of fruit-trees, choosing good situations; your wall and espalier trees ought to have ample room, not less than twenty feet asunder: in a few years, they will cover well, and bear rich crops; standards ought to be full forty feet apart: if the weather proves severe, defer this work until it moderates, and look well to your old trees, covering their roots with litter, and supporting newly planted standards with stakes, leaning on hay-bands, so as not to injure the bark. Prune old standards, and begin the forcing of hot-house plants, by closing well up, and keeping a temperature of from seventy-five to eighty degrees, Fahrenheit. As the fruit begins to ripen, allow water in moderation. Your strawberries will particularly come under notice in the forcing time; and all the potted plants must be placed in hot-beds for that purpose.

In your Flower-garden, see that the auriculas, carnations, hyacinths, and tulips be well sheltered from inclement weather. You may now plant tulips, anemones, ranunculuses, crocuses, jonquils, narcissuses, hyacinths, and all other bulbs, or you may set the roots on mantle or chimney-pieces, on glasses filled with water. Let all your perennial fibrous-rooted plants, such as double wall-flowers, double stocks, double sweet-williams, chrysanthemums, &c. &c. that are in pots, or under frames, be carefully attended to. Cover seedlings and

tender plants, not omitting to give air in mild weather. You should now prune and dig between your flowering shrubs; and may plant out roses, honeysuckles, lilacs, laburnums, privets, jasmines, and a great variety of the hardy class, observing to arrange them tastefully, according to their colours, foliage, &c., and setting those which are tallest, when full grown, in the back part, whereby you will not obscure the lesser kinds. All hardy shrubs may now be propagated by layers; and suckers may be removed from roses, syringas, spiræas, lilacs, &c. into rows, where they should stand for about two years, and then be set out to where they are to remain; cuttings of hardy deciduous shrubs will now proceed. Trim your grass-walks and lawns, throwing down worm-casts, and rolling with a wooden roller. You may at this season pare and lay turf. In dry weather, lay down and roll the gravel walks that were ridged; plant thrift and box edgings, if not done in Ootober or November. Forest and ornamental trees should now be planted on dry soils; these should, properly, be of the hardy kinds. Hedges may be planted or plashed.

In the Nursery. Transplant and prune your forest-trees, particularly those that are deciduous, if the weather admits; for evergreens the weather must be settled; prune and transplant flowering shrubs; plant fruit-tree stocks, and prepare for extensive plantings and sowings; in frosty weather carry dung, &c., losing no time; take great care of young and seedling trees; propagate by cuttings.

In the Hot-house. Your pines will require great care; you may also raise kidney-beans, cucumbers, strawberries, &c., and have abundance of flowering plants therein.

FEBRUARY.

Kitchen-garden. Cucumbers and melons will be sown with better success in this, than in the former month; but take care they have not too much heat, as they will be apt to wither; to prevent this, let them be sown or set upon little hillocks or ridges, which will expose a greater surface to the air; stop, *i. e.* pinch off, the young plants at the first joints of the first shoots, so as to cause their sending out many fruitful runners; do this when they have two rough leaves, not longer than a shilling; force asparagus in hot-beds, breaking off the shoots with your finger, avoiding to cut them; kidney-beans, small salading, &c. may proceed, as shewn in the last month's directions; give your cauliflower-plants air, and by the end of the month you may plant out to two feet asunder, taking care to cover with haulm, &c.; if the weather comes on very cold, leave one plant under each glass; sow cauliflower seed, transplant cabbages, sow cabbage and savoy seeds, also early celery, radishes of sorts, spinach, lettuces, carrots, parsnips, beets, leeks, onions, beans, peas, pot-herbs, potatoes, horse-radish, turnips, liquorice, &c. for a general crop; taking care to break the soil well, and to choose favourable times for putting in the seeds, or sets.

In the Fruit-garden. Continue to prune fruit-trees, and especially vines, dress strawberry beds, plant fruit-trees, dig the borders, graft, and go on forcing the early flowers and fruits.

In the Flower-garden. You may sow tender annuals on hot-beds, during the early part of the month; and towards the end all the hardy annuals; plant out the hardy fibrous rooted plants, such as primroses, violets, polyanthuses, &c; dress your auriculas, and sow their seed; also those of the polyanthus, in rich, light earth, very shallow; transplant your carnations, defend bulbous roots, prune flowering shrubs, plant out such as are wanted, together with evergreens; plant hedges, lay turf, trim lawns and walks, set box, &c. for edgings.

In the Nursery. Propagate by cuttings, suckers, and layers; transplant layers, flowering shrubs, stocks to graft on, fruit and forest trees; sow seeds of ditto, and head down budded stocks.

In the Green-house. Look to the shrubs, &c.; giving air, and water, in proportion to the mildness of the weather. You may now trim myrtles, oranges, &c. to any intended form.

In the Hot-house. The pines will demand much assiduity; for an improper degree of heat will at this period injure them very considerably: keep up to 75 degrees, by means of fresh bark to be mixed with that in which the pots were plunged. Moderate watering will contribute both to growth and flavour. Keep your exotics very clean from decayed leaves, and wash, dust, &c. from the leaves; above all things, remove cob-webs wherever they appear; and, if necessary, fumigate to destroy insects, which will now begin to shew themselves. Fresh air must now and then be admitted, when the weather admits. Your straw-

berries, kidney-beans, cucumbers, roses, &c. will now get fast forward; but you must guard against frost, which would do great injury if your fires were neglected.

MARCH.

Kitchen-garden. Attend to your cucumbers and melons; you may now sow the seeds of the later sorts; such as the Smyrna, the long green, and long white Turkey kinds. Make new hot-beds, to receive them when fit to transplant. About this time, your cauliflower-plants may be removed from the warm borders, and set out; these will now occupy the beds of your spinach and radishes, which will soon be gone, and leave only the cauliflowers. Sow brocoli for an autumnal crop; also cabbages, some of which may now be transplanted. Sow savoys, and lettuces, also spinach, leeks, onions, borecole, radishes of sorts, carrots and parsnips, all on good soil, well prepared, and made very fine; fork and dress up your asparagus, and plant out where wanted; you may also sow some seed; dress your artichokes, and plant out; set beans for a full crop, also peas; earth-up any that are grown sufficiently; sow turnips for a full crop, also celery, small salad, and all the tribe of medical and pot herbs; nasturtiums may be sown very early in this month; capsicums should be in a hot-bed, and be set out as the weather grows warm, after they have four leaves; if six, or eight, the better. Love-apples will require the same treatment; kidney-beans, potatoes, and Jerusalem artichokes, should not be omitted. Set slips of rosemary, rue, chives, mint; and let your garlick, scallions, cardoons, &c. now be committed to the soil.

In the Fruit-garden. Prune your fig-trees, and plant also where they are wanted; if your wall-fruit trees have not been trimmed, lose no time in attending to them; some will be in bloom, if the season favours; cover such with mats at night, to keep the frost from injuring them. Fruit-trees in general may yet be planted out, but no time should be lost; and the borders in which they stand should now be well dug. Prune vines, and propagate by means of cuttings. It is expedient to remark, in this place, that it has been recently proposed to graft vines upon elders at this season, under the idea of producing early fruit, and of giving the clusters more time for ripening; the suggestion is assuredly ingenious, and merits trial. Dress your straw-berries well, and run light wisps of straw at right angles under the foliage, so as to support the leaves, and to retain the moisture in the soil. Continue to force your early fruit, taking care to keep up fires every night.

In the Flower-garden. You will find ample employment in setting out your early annuals, sowing tender annuals on hot-beds, and the more hardy sorts in warm borders. Fresh earth must be given to plants in pots; the chrysanthemums, auriculas, carnations, hyacinths, &c. will now demand care, as will all your curious flowers. Now plant anemones, and ranunculuses, and sow the fibrous-rooted annuals and biennials; transplant perennials, prune your shrubs, hoe and rake your borders, dig where necessary, and clean your clumps; plant deciduous flowering shrubs, and forest-trees; transplant your evergreens, remove roses, plant edgings and hedges, clean your garden wall, clear your gravel walks from rubbish, lay your turf where wanted, and roll your lawns very smooth in dry weather.

In the Nursery. Graft on proper stocks, sow the seeds of deciduous trees and shrubs, propagate also by cuttings, sow hardy evergreens; weed the whole carefully, and water seedlings.

In the Green-house. Moderate the heat by admitting fresh air in mild weather; if frosty, or very cold, keep all shut close; trim your orange-trees, myrtles, &c. into shape; shift such plants as require larger pots, give fresh earth to the roots in general; sow the seeds of exotics, and of oranges for stocks.

In the Hot-house. Your pines will begin to shew fruit; therefore keep up the heat, water these plants frequently, and, in favourable days, admit a little air.

APRIL.

Kitchen-garden. Keep up your hot-beds for cucumbers and melons, allowing the young plants air daily; give water occasionally, and remove decayed leaves; if the sun is very powerful, put mats, &c. over your glasses; impregnate the female flowers, by means of the fine powder on the antheræ of the male blossoms, this will insure an early crop, and should be done on the day the flowers first open; make hot-bed ridges, to receive the plants intended to be set out under bell or hand glasses; sow melon and cucumber seeds for a late crop, plant out your lettuces, sow small salading, radishes, turnips, spinach, kidney-beans, brocoli, onions, leeks, cardoons, carrots, parsnips, pot-herbs, capsicums, love-

apples, scorzonera, salsafy, purslane, beans, peas, gourds, and pompions; set potatoes for a late crop, and plant slips of pot and sweet herbs; destroy weeds, and water young plants when the weather is dry.

In the Fruit-garden. You may plant trees, propagate vines, summer-dress the old ones, protect the blossoms of wall-fruit, rub off useless buds, and thin the fruit where too numerous; you may yet prune, and graft, or bud; destroy insects and weeds, clean your strawberries very carefully, and clear them from runners, except what you keep for planting out in June; water these plants well, or they will bear but poorly.

In the Pleasure-garden. You may yet sow tender annuals on hot-beds; the more hardy will succeed with less heat, and the hardy will only require warm clean borders: your bulbous roots will be in blossom, and must be amply watered; in very hot weather you must shade them, or they will soon pass off; carnations and polyanthuses may yet be sown; those in pots will demand attention; transplant fibrous rooted perennials, sow some also; set your tuberoses in hot-beds, or in hot-houses; pay attention to your auriculas, and save their seed very carefully; sow balm of Gilead, plant out evergreens and flowering shrubs, propagate them; roll your grass-walks often, and, if too luxuriant, mow them; plant box and thrift edgings, put sticks to your flowering plants, roll your gravel-walks after turning them, and destroy weeds every where.

In the Nursery. Finish sowing evergreens, flowering-shrubs, and tree-seeds; water your seed-beds, transplant evergreens, examine your grafts, and make new ones early in the month.

In the Green-house. Give air to your plants, water and shift into larger pots or tubs, put fresh earth, cleanse the plants, head down myrtles, &c., inarch, and propagate by seeds and cuttings.

In the Hot-house. Your pine-apples will demand daily attendance, and must be liberally supplied with water, keep the heat well up, admit air occasionally in suitable weather; stove exotics may now be propagated by seeds, cuttings, layers, or suckers.

MAY.

Kitchen-garden. As your melons and cucumbers will be getting fast forward, you must carefully keep up the heat of your beds by fresh linings of dung, and screen from cold at night; in the day, give air at suitable times, and occasionally water moderately. You will now, in all probability, have occasion to raise your glasses, so as to give room; do this by putting bricks, &c. under the frames. As the melons set, place a tile under each, else the damp of the bed will stain and render the lower part unsightly. You can now sow cucumbers for pickling; this may be done in a free soil, fully exposed to the sun. At night cover the young plants with straw, &c. You may also sow gourds, &c. This is a good time for a full crop of kidney beans, and, if fair, for the scarlet runners: put in small salading, spinach, turnips, carrots, pasnips, onions, for succeeding crops; taking care to weed and water those formerly sown: set out cabbages and savoys; screen your cauliflowers from the sun, by bending in the leaves over the flowers, which will now be forming: water these plants well, making a trench, or bason, for that purpose: transplant cauliflowers, and sow for a Michaelmas crop. Sow brocoli, borecole, beans, peas, &c. and stick the peas which are ready; top off your blossoming beans; sow endive, for an early crop, propagate pot-herbs and aromatics by cuttings, &c. Support seeding plants, prick out celery, and sow some, also some radishes; thin your cardoons, and weed with diligence: if the weather proves dry, water liberally.

In the Fruit-garden. Look to your wall trees, protect from birds and insects, which by the end of the month will be pecking at your early fruits; trim the shoots and leaves of all fruit-trees, to allow the fruit sun and air, but without scorching; thin your wall-fruit where too close or abundant; destroy snails, keep your borders clean, fumigate to kill small insects, water new planted trees; clear away superfluous clusters from your vines, look to your strawberries, watering them amply; examine grafted trees.

In the Flower-garden. Be attentive to your bulbous flowers, take up such as have lost their leaves, and lay them to season; your carnations will require care, trim off all puny flowers; your tender annuals must be again removed to a fresh hot-bed; those sown last month may now be pricked out: the less tender may be set out into open spaces, if the weather is warm, choosing moist weather for that operation. You may sow hardy annuals, and propagate double flowers by slips: preserve seedling bulbs from too great heat. When your

auriculas have done flowering, remove them to the open air; plant tuberoses for the next year, transplant perennial flowers, and sow some of their seeds; destroy weeds, mow your lawns, and keep your gravel walks perfectly clean.

In the Nursery. Water seedlings, and shade them, if hot weather; propagate evergreens by layers, and look over your grafts.

In the Green-house. A free circulation should be allowed, and the plants be gradually introduced to the open air; remove decayed parts, and shift into larger vessels where wanted; water freely, and propagate by layers and cuttings.

In the Hot-house. Your pines will want water often, and fresh air occasionally; you must look to your exotics, and propagate by seeds, cuttings, suckers, &c.

JUNE.

Kitchen-garden. Your melons must be protected from excessive heat by mats over the glasses, which they will now bear to be well raised, water them and your cucumbers; all under bell-glasses should have free range; thin out the gerkin plants, leaving four in each hole, setting out the rest as before directed into ridges, &c. You may yet sow for pickling; transplant celery into trenches for blanching, also endive; set out lettuces, and sow more seed; sow radishes, and small salading; prick out cauliflowers, and pay attention to those now getting forward, save some seed from the best heads; sow a full crop of turnips for autumn; weed and loosen about your carrots and parsnips, also your beets; thin and clear your onions; transplant leeks, brocoli, and borecole; plant kidney and running beans; sow peas and beans for late crops, and a full crop of cabbages and savoys for winter. Cut no asparagus after this month; plant pot-herbs, gather mint, plant out capsicum, love-apples, and basil; water freely every where; weed carefully, set out cardoons for blanching; sow spinach and radishes; and keep your manure compact, so as not to be injured by the heat.

In the Fruit-garden. Keep your wall-fruit clean from insects, and guard against birds; thin the sets where too numerous. Where apple, pear, plum, &c. trees have made shoots, regulate them duly, taking off all that would be superfluous, close to the stems; new planted trees should be examined, and eventually watered. Look over your vines again; towards the end of the month you may bud, or inoculate some fruit trees. Clear your strawberry beds from suckers, and set out where you want new beds, or to supply vacancies. Destroy snails, and scare birds.

In the Flower-garden. Transplant hardy annuals, water tender annuals; some quick flowers may yet be sown to blow in autumn, take up bulbs that are past flowering, transplant Guernsey and Belladona lily roots, propagate fibrous rooted plants, transplant seedlings, look to your carnations and pinks, both old and seedlings, lay them, as also double flowers of various kinds, propagate by pipings, (or cuttings,) cut edgings, clear away weeds, water freely, mow lawns and valles, and clip hedges.

In the Nursery. You may inoculate stove-fruit trees, examine last year's buds, graft in general; inoculate roses; propagate hardy exotics, water seedlings, and shade them; water trees newly planted, and transplant seedling pines, firs, &c.

In the Green-house. Admit air to the fullest extent, and bring the plants out into the open air; water and stir the soil in the pots, wash off dust, destroy insects, cleanse the interior well, plant cuttings and slips of myrtle, geranium, &c. Propagate succulent plants, letting the cuttings remain in a dry airy place about ten days. You may inarch upon orange and lemon trees, make layers of green-house shrubs, and transplant seedling exotics.

In the Hot-house. Give fresh air and abundance of water, but not too much at a time: take off the crown and side swellers from the ripe fruit, as they will in two years bear fruit.

JULY.

Kitchen-garden. Plant out the principal crops of cabbages, &c. watering them well for several days; plant out brocoli, and sow seed for spring crops; transplant endive, and sow seed for winter crops; you may yet sow kidney and scarlet beans; set out the cauliflowers sown in May; sow small salading and winter onions, also carrots for autumn; transplant celery, and land up that formerly set out, sow turnips; plant out lettuce, sow some seed also of winter spinach, radishes, and cole-worts; pull onions, garlic, and shallots; be prudent in not giving much water to your ripening melons, as it would hurt their flower; for the same reason shelter them from heavy rain. When you have cut artichokes, break the stem down close to the root. Set out cardoons, gather seeds, transplant leeks,

collect herbs for distilling while early in flower; plant sage, &c. gather physical, and pot-herbs for drying; sow peas and beans for a late crop; water freely and clear your ground.

In the Fruit-garden. Look to your wall trees, nail up your fig-trees, look again to your vines in particular, destroy wasps and insects, not forgetting snails. Bud your stone-fruit-trees, and preserve seeds.

In the Flower-garden. Bring out your curious annuals that were as yet in frames, &c. clear them well, and wash well with a light pot pierced very small; transplant annuals into the borders, &c.; select carnations which must be carefully preserved, lay them, as also double sweet-williams, &c. transplant former layers, propagate pinks by pipings; set out perennial plants, clean your auriculas, transplant their seedlings; take up remaining bulbs, propagate the double scarlet lychnis, &c. by cuttings; mow lawns and walks, cut edgings, and clip hedges; destroy weeds, and cut away decayed flower-stems.

In the Nursery. Bud your stone-fruit-trees; grafted trees are to be examined; transplant seedling firs; inoculate and lay curious shrubs; water freely, and destroy weeds.

In the Green-house. Water your bearing trees in particular; give them new soil; propagate exotics by cuttings, &c. plant cuttings of succulents; bud your oranges and lemons.

In the Hot-house. Admit air in calm clear weather; propagate pines as before shewn; water moderately, and pay attention to your exotics.

AUGUST.

Kitchen-garden. Sow a full crop of winter spinach, also cabbages, brocoli, savoys, winter onions, carrots for spring use, radishes, some cauliflowers for next summer; transplant celery, and earth-up former trenchings; sow small salading, lettuce, fennels, angelica, carduus, endive, coleworts, &c.; clean your beds of asparagus; earth-up cardoons; look to your onions, garlic, and shallots; propagate sweet-herbs; gather seeds; and see to your melons and cucumbers, which will now be in bearing. You may likewise sow turnips for a late crop: hoe your former crops well in dry weather.

In the Fruit-garden. Keep your wall-fruit very clean, and guard against birds and vermin; let your figs have a due exposure to the sun; look to your budded trees: you may still bud early in this month.

In the Flower-garden. Propagate fibrous-rooted plants; water generally; propagate saxifrage in particular; sow auricula seeds, and shift those plants into fresh earth, pick out their seedlings; remove carnation layers and pink pipings; lay carnations; sow seeds of bulbs, also of the anemone, cyclamen, and ranunculus; remove late flowering bulbs; transplant perennials; clip hedges; cut edgings; mow lawns; trim flower-plants, and gather their seeds; plant autumnal bulbs; and destroy weeds very carefully.

In the Nursery. Water freely; transplant seedlings; trim evergreens; bud in the early days; and prepare ground for transplanting.

In the Green-house. Shift succulent plants into larger vessels; propagate aloes by offsets from the old plants; inoculate orange trees; and water so as to keep the soil from caking.

In the Hot-house. Water freely every other day; shift the succession of pine-apples into larger pots, in which they are to bear; give but little water to ripening pines, lest the flavour be weakened.

SEPTEMBER.

Kitchen-garden. Now prepare your beds for mushrooms, making them of the best fresh stable dung, in which the best spawn should be set; if heavy rain should fall before completed, cover with long dry litter; take care only to cover the spawn about half an inch. Keep these beds very dry in winter; in very hot weather sprinkle occasionally with water. A mushroom bed will produce in five or six weeks; and old cucumber beds will often produce immense numbers. Plant and sow lettuces; put some also into frames for winter service. Set out your young cauliflowers into a nursery bed, to stand the winter. Earth-up the Michaelmas cauliflowers, and urge them to perfection, watering them abundantly, else they will be stunted. Transplant your young brocoli. Plant out your late savoys and cabbages, also your celery and coleworts. Earth-up your ridged celery. Tie up endive to blanch, and plant out more for a succession. Begin to blanch the more forward cardoons. Weed your young spinach and winter onions. Hoe your turnips in dry weather with a bold hand. Continue to sow small salading, chervil, &c.; and gather your ripe seeds in fair weather.

In the Fruit-garden. Thin the leaves from over your ripening wall-fruit, especically your grapes; hang up phials of syrup every where, to decoy wasps and flies; gather your apples and pears; prepare for plantations of fruit trees; and set out strawberries at good distances.

In the Flower-garden. Plant your hyacinth and tulip roots for early bloom; prepare beds for your ranunculuses and anemones, sorting the seed late in the month; look to your carnation layers, and to your auriculas that are in pots; sow auricula seed, if not done before; transplant perennials; sow seeds of bulbs; plant box; dig borders; roll gravel walks; trim flowering plants; propagate fibrous-rooted plants; transplant pionies, and other knot-rooted plants; as also flowering shrubs in general.

In the Nursery. Transplant evergreens, deciduous shrubs and trees; prepare ground for receiving your late grafts, and for new stocks; propagate trees and shrubs by cuttings; preserve cherry and plum stones to raise stocks; and destroy weeds and nests of vermin.

In the Green-house. Prepare for the return of your oranges, &c. which, as the weather becomes colder, must be taken in, and gradually be more confined in regard to the atmosphere.

In the Hot-house. Admit air only when the sun is bright, and the wind from a warm quarter; water your pine plants moderately; add fresh tan to your pits; and prepare composts for this branch.

OCTOBER.

Kitchen-garden. Plant beans for an early crop, preferring mazagans; you may also sow some hotspur peas for the same purpose; transplant lettuces for winter service, and sow some for spring use; cover your cauliflower plants; set out your cabbages; force your brocoli, by loosening the soil, and drawing it around their stems; clean your winter spinach, tie up endive, and dress your bed of aromatics; plant and set slips of herbs; dress asparagus beds; earth-up celery and cardoons; sow small salading and radishes, also carrots for spring use; dig up carrots, parsnips, and potatoes; begin trenching for the benefit of winter exposure.

In the Fruit-garden. Gather your late pears and apples; prune and nail your wall-trees, also your standards, when the leaf has fallen; plant gooseberries and currants, also prune them, and set the cuttings; dress strawberry beds, plant the runners; prune raspberries, and plant the young shoots; propagate fruit trees by layers and by suckers.

In the Flower-garden. Put your auricular plants in safe places, laying them on their sides to throw off the wet; set out your carnation layers; dress your flowering shrubs; transplant fibrous-rooted flowering plants, parting the roots of such as will admit; plant all kinds of bulbs; prune flowering shrubs; plant hardy deciduous flowers and shrubs, and evergreens to hide walls; firs and pines should now be transplanted, as also forest trees in general; propagate them by layers; transplant such layers as may be ready; propagate roses, &c. by suckers, and others by cuttings; set your seedlings in a warm place; trim your evergreens, plant box; and cut hedges and edgings.

In the Nursery. Propagate by layers, and transplant such as may be ready; proceed also with cuttings; sow haw and holly berries; sow acorns; set out seedling stocks for grafting; sow plum and cherry stones; transplant laurels; sow beech, and various seeds of hardy trees.

In the Green-house. See that your shutters fit well, and have all your benches, &c. well cleansed and repaired; move in your plants in due time, if not done before; water occasionally, but in small quantity.

In the Hot-house. See that your tan-pits are in proper state, and set your pots in carefully.

NOVEMBER.

Kitchen-garden. Sow beans, peas, radishes, small salading, &c.; look to your celery and endive, so that they may blanch well; attend also to your cardoons; cut down your artichokes; give air to your cauliflower plants; clean your spinach; manure and trench; you may sow a little carrot seed, but it will prove a precarious crop; weed your spring onions carefully.

In the Fruit-garden. Prune and nail vines, apricots, &c.; plant wall-trees, apples, pears, cherries, &c.; clear your fig-trees of the remaining fruit, and if severe frosts come on, cover them with mats; plant filberds, and in general all deciduous fruit trees and shrubs.

In the Flower-garden. Clean your borders; plant perennials, tulips, ranunculuses, anemones, crocuses, narcissuses, and other bulbs; prune flowering shrubs; transplant hardy shrubs; plant forest trees; roll grass

walks and lawns, and keep your gravel clean; prepare good compost for your flowers.

In the Nursery. Finish all transplanting; prepare for new plantations; manure well; and shelter seedlings from wet and from frost.

In the Green-house. Some few plants will want watering, and it will be proper to keep the night air entirely out.

In the Hot-house. Make a moderate fire at night; on sunny days you must open a sash or two, and should occasionally bestow a little water where wanted.

DECEMBER.

Kitchen-garden. Examine your cauliflower plants; you may sow beans, peas, &c. if the weather is open; keep your mushroom beds dry; make a forcing bed for early asparagus; trench and open the vacant soil, giving a good allowance of manure where wanted.

In the Fruit-garden. See that your wall-trees are firm, and cover places that seem likely to canker, cutting away all useless wood, but preserving sufficient bearing wood; prune fruit trees in general, and plant out if the weather admits.

In the Flower-garden. Preserve all tender plants and seedlings very carefully; transplant and plant as wanted.

In the Nursery. Look to your new plantations; trench, dig, and manure liberally; propagate by layers and suckers of hardy trees and shrubs.

In the Green-house. Keep your plants clean, and water occasionally.

In the Hot-house. Water as wanted; keep up a due temperature; you may commence for early cucumbers, kidney-beans, roses, pinks, &c.

GARDEN *snail.* See HELIX.

GARIDELLA, in botany, so called in honour of Pierre Garidel, M. D. a genus of the Decandria Trigynia class and order. Natural order of Multisilique. Ranunculaceæ, Jussieu. Essential character: calyx five-leaved, like petals; nectary five, two-lipped, bifid; capsule three, connected, containing many seeds. There is but one species, *viz.* G. nigellastrum, fennel-leaved garidella.

GARLAND, in naval affairs, a sort of net extended by a wooden hoop, of sufficient size to admit a bowl or platter, and is used by sailors as a locker or cupboard, to contain their provisions, being hung up to the beams within the birth, where they commonly mess between the decks.

GARLIC, in botany, see ALLIUM. This root has been subjected to chemical analysis; when distilled, it yields first a liquid slightly coloured, and having an acrid taste; then a thick brown oil, and abundance of inflammable air and carbonic acid. The liquid in the receiver emits the smell of ammonia when mixed with lime. It is said to consist of

Albumen,	Fibrous matter,
Mucilage,	Water.

GARNET, in mineralogy, is a species of the flint genus, of which there are two subspecies, *viz.* the precious, and common garnet. The precious, or Oriental, garnet, is red, but of various shades; it occurs seldom massive, more often disseminated, and in original roundish grains and small pieces. It occurs most commonly crystallized, either as a dodecaedron, or as a double eight-sided pyramid. Its specific gravity is about 4.3, and it consists of

Silica	35.75
Alumina	27.25
Oxide of Iron	36.0
Marganese	0.25
	99.15
Loss	0.75
	100

Before the blow-pipe it melts into a black enamel.

The common garnet is brown or green, is not so heavy as the precious, and is composed of

Silica	26.46
Alumina	22.70
Lime	17.91
Iron	16.25
	83.32
Loss	16.68
	100

It is more easily melted than the precious garnet.

"The garnet varies more than any other gem, both in the form of its crystals, and in its colour; some being of a deep red, some yellowish, or of a purple tint, and others brown, blackish, and quite opaque. They are generally of a spherical form, and never crystallize with less than twelve sides. The prevailing colour is a fine red, and the mean size that of a large pea, though they

are found from the size of a grain of sand to three or four inches in diameter. Those imbedded in granite are in general of the smallest size, but at the same time the most transparent. Among the garnets which are called Oriental, may be distinguished three different shades, known in commerce by as many different names. The garnet of a fine red colour, and free from any mixture, is called a carbuncle. Garnets are found in almost every country where primitive rocks exist. Switzerland and Bohemia are the two countries in Europe which furnish them in the greatest abundance. Those of Bohemia have a tint of orange mixed with the red, from whence some have given them the name of rubies. These stones are likewise found in Hungary, at Pyrna in Silesia, in Spain, and in Norway. At Bareith, a town in Germany, garnets are found in little irregular masses, of a fine red colour, and abundantly disseminated in a green semi-transparent stone called serpentine. As they are susceptible of a fine polish, the inhabitants form them into several pretty trinkets and other articles of jewellery. Black garnets are met with in different situations. Ramond, professor of natural history at Tarbes, collected some from a mountain of the Pyrenees in the neighbourhood of Barége; Romé de l' Isle found them in the diamond mines of Brazil; and Brongniart tells us that they have been discovered in a volcanic rock near Vesuvius, and in the basaltes of Bohemia. When garnets are perfectly transparent, and hard enough to bear a fine polish, the lapidaries cut them into facits to be employed as jewels. In Bohemia there are places where they work the garnets which are found in their neighbourhood. There are workshops also at Friburg, in Brisgaw, for the garnets which are collected from several of the Swiss mountains. The impure garnets are used to advantage as a flux when they are found near iron-mines, as they not only facilitate the fusion of that metal, but add something to the mass by contributing the portion of iron which generally enters into their composition. The quantity indeed is sometimes so great, that they have been said to yield 40*lb.* in the *cwt.* and consequently worth smelting alone for the sake of their produce." See Wood's "Zoography," to which we have been indebted in the articles Coal and Ficus.

Garnet, in a ship, is a tackle having a pendant coming down from the main-mast, with a block well seized to the main-stay, just over the hatch-way, to which a guy is fixed to keep it steady; and at the other end is a long tackle-block, in which the fall is reeved, that so by it any goods may be hauled and hoisted into or out of the ship.

GARNISHEE, the party in whose hands money is attached, within the liberties of the city of London, so used in the Sheriff of London's court, because he has had garnishment, or warning, not to pay the money, but to appear and answer to the plaintiff creditor's suit.

GARNISHMENT, a warning given to one for his appearance for the better furnishing of the cause and court.

GARRISON, in the art of war, a body of forces, disposed in a fortress, to defend it against the enemy, or to keep the inhabitants in subjection; or even to be subsisted during the winter-season: hence, garrison and winter-quarters are sometimes used indifferently, for the same thing; and sometimes they denote different things. In the latter case a garrison is a place wherein forces are maintained to secure it; and where they keep regular guard, as a frontier town, a citadel, castle, tower, &c. The garrison should always be stronger than the townsmen.

GARTER, *order of the*, a military order of knighthood, the most noble and ancient of any lay-order in the world, instituted by King Edward III. This order consists of twenty-six knights-companions, generally princes and peers, whereof the King of England is the sovereign, or chief. They are a college or corporation, having a great and little seal.

Their officers are a Prelate, Chancellor, register, king at arms, and usher of the black rod. They have also a dean with twelve canons, and petty canons, vergers, and twenty-six pensioners, or poor knights. The Prelate is the head. This office is vested in the Bishop of Winchester, and has ever been so. Next to the Prelate is the Chancellor, which office is vested in the Bishop of Salisbury, who keeps the seals, &c. The next is the register, who by his oath is to enter upon the registry, the scrutinies, elections, penalties, and other acts of the order, with all fidelity. The fourth officer is garter, and king at arms, being two distinct offices united in one person. Garter carries the rod and sceptre at the feast of St. George, the protector of this order, when the Sovereign is present. He notifies the

elections of new knights, attends the solemnity of their installations, carries the garter to the foreign princes, &c. He is the principal officer within the college of arms, and chief of the heralds.

All these officers, except the prelate, have fees and pensions. The college of the order is seated in the castle of Windsor, with the chapel of St. George, and the chapter-house, erected by the founder for that purpose. The habit and ensign of the order are a garter, mantle, cap, George, and collar. The four first were assigned the knights companions by the founder; and the George and collar by Henry VIII. The garter challenges pre-eminence over all the other parts of the dress, by reason that from it the noble order is denominated; that it is the first part of the habit presented to foreign princes, and absent knights, who, and all other knights elect, are therewith first adorned; and it is of so great honour and grandeur, that by the bare investiture with this noble ensign, the knights are esteemed companions of the greatest military order in the world. It is worn on the left leg between the knee and calf, and is enamelled with this motto, HONI SOIT QUI MAL Y PENSE; *i.e.* "shame to him that thinks evil hereof." The meaning of which is, that King Edward having laid claim to the kingdom of France, retorted shame and defiance upon him that should dare to think amiss of the just enterprize he had undertaken, for recovering his lawful right to that crown, and that the bravery of those knights whom he had elected into this order, was such as would enable him to maintain the quarrel against those that thought ill of it.

The mantle is the chief of those vestments made use of upon all solemn occasions. The colour of the mantle is by the statutes appointed to be blue. The length of the train of the mantle only distinguishes the Sovereign from the knights companions. To the collar of the mantle is fixed a pair of long strings, antiently woven with blue silk only, but now twisted round, and made of Venice gold and silk, of the colour of the robe, with knobs, or buttons, and tassels at the end. The left shoulder of the mantle has from the institution been adorned with a large garter, with the device HONI SOIT, &c. within this is the cross of the order, which was ordained to be worn at all times by King Charles I. At length the star was introduced, being a sort of cross irradiated with beams of silver.

The collar is appointed to be composed of pieces of gold in fashion of garters, the ground enamelled blue, and the motto gold.

The manner of electing a knight companion into this most noble order, and the ceremonies of investiture, are as follow: when the Sovereign designs to elect a companion of the garter, the Chancellor belonging to this order draws up the letters, which passing both under the Sovereign's sign manual and signet of the order, are sent to the person by garter principal king at arms, and are in this manner, or to the same effect. "We, with the companions of our most noble order of the garter, assembled in chapter, holden this present day at our castle at Windsor, considering the virtuous fidelity you have shewn, and the honourable exploits you have done in our service, by vindicating and maintaining our right, &c. have elected and chosen you one of the companions of our order. Therefore, we require you to make your speedy repair unto us, to receive the ensigns thereof, and be ready for your installation upon the —— day of this present month, &c."

The garter, which is of blue velvet, bordered with fine gold wire, having commonly the letters of the motto of the same, is, at the time of election, buckled upon the left leg, by two of the senior companions, who receive it from the Sovereign, to whom it is presented upon a velvet cushion by garter king at arms, with the usual reverence, whilst the Chancellor reads the following admonition, enjoined by the statutes. "To the honour of God omnipotent, and in memorial of the blessed martyr St. George, tie about thy leg, for thy renown, this noble garter; wear it as the symbol of the most illustrious order, never to be forgotten, or laid aside; that thereby thou mayest be admonished to be courageous, and having undertaken a just war in which thou shalt be engaged, thou mayest stand firm, valiantly fight, and successively conquer."

The princely garter being thus buckled on, and the words of its signification pronounced, the knight elect is brought before the Sovereign, who puts about his neck, kneeling, a sky-coloured ribbon, whereunto is appendant, wrought in gold within the garter, the image of St. George on horseback, with his sword drawn, encountering with the dragon. In the mean time, the Chancellor reads the following admonition: "Wear this ribbon about thy neck, adorned with the image of the blessed martyr and soldier of Christ, St. George, by whose imitation provoked, thou mayst so overpass

both prosperous and adverse adventures, that having stoutly vanquished thy enemies both of body and soul, thou mayest not only receive the praise of this transient combat, but be crowned with the palm of eternal victory."

Then the knight elected kisses the Sovereign's hand, thanks his Majesty for the great honour done him, rises up, and salutes all the companions severally, who return their congratulations.

GAS. This term was first applied by Van Helmont, to denote the permanently elastic exhalations afforded in chemical processes. Dr. Priestley, whose extensive and successful researches into this department of natural philosophy in the space of a few years produced a revolution in the science of chemistry, used the word air as the generic term for permanently elastic fluids. Other chemical writers of great reputation have thought fit to revive Van Helmont's term, and confine the word air to the atmospheric fluid. As this has been found convenient, to prevent confusion of ideas, it is now generally adopted; the gases which are not fully treated under the articles of their respective bases, will properly find a place here.

GAS, *ammoniacal*. See AMMONIA.

GAS, *carbonic acid*. This is the first of the elastic fluids that appears to have been distinguished from common air, though its nature was not properly understood till it was investigated by Dr. Black. Its deadly properties, as it is met with in subterranean cavities, particularly the celebrated Grotto del Cano near Naples, occasioned it to be distinguished by the name of spiritus lethalis. Van Helmont first gave the name of gas, from a German word equivalent to our spirit, to this vapour produced from burning charcoal. He likewise called it spiritus sylvestris, and when arising from fermented liquors spiritus vinosus. From its existing in the inelastic state, in water, it was called fixed air, a name which Black and others long retained; Bewley termed it mephitic air, from its great abundance in nature combined with lime in the form of chalk, and it has been named the cretaceous and the calcareous acid, subsequent to the discovery of its acid nature. But carbonic acid has superseded all those, since it appears to have been ascertained, that its radical is carbon. Of this, or rather of charcoal, according to the experiments of Lavoisier, it contains twenty eight parts by weight, to seventy-two of oxygen. Guyton Morveau considers it as composed of 17.88 pure carbon, and 82.12 of oxygen.

Carbonic acid gas exceeds every other in specific gravity, except the sulphurous. Hence the vapour in the Grotto del Cano, rises but a little above the surface; and the choak damp of miners, which is this gas, lies on the ground. Thus, too, when it is emitted from a fermenting liquor, it first fills the empty portion of the vat, displacing the lighter atmospheric air; and then flows over the sides, almost as water would do. For the same reason, if a bottle filled with it be inverted over the flame of a candle at some distance, it will descend, and extinguish it. According to the experiments of Mr. Cavendish, one part of this, mixed with nine of atmospheric air, renders it incapable of supporting combustion.

From the powerful attraction of carbon for oxygen, the base of this gas is not easily decomposed; but Mr. Tennant effected it by introducing phosphorous into a coated glass tube, closed at one end, and over this powdered marble. A very small aperture only being left in the other end of the tube, and a red heat applied for some minutes, phosphate of lime and charcoal were found in the tube. Dr. Pearson did the same with phosphorus and carbonate of soda.

The carbonic acid gas, is likewise decomposed in part by hydrogen gas, assisted by electricity. In a glass tube eight lines in diameter, De Saussure exposed a column of four inches in height, of carbonic acid gas, and three inches of hydrogen gas, over mercury, to the action of the electric fluid circulating between iron conductors, for twelve hours. The gases were at first condensed very rapidly, but by degrees more and more slowly, till in this period they were reduced to four inches. Of this, one inch was absorbed by potash, being carbonic acid gas, and the other three were nearly pure carbonic oxide, the hydrogen having formed water with the oxygen, abstracted from the carbonic acid. The mercury and the conductors were but very little oxyded. De Saussure had previously found, that carbonic acid, and hydrogen gases standing together over mercury, for the space of a twelvemonth had decreased in volume.

GAS, *carbonic oxide*. This gas was first made known, by Mr. Cruickshank. Dr. Priestley had observed, that, when scales of iron mixed with charcoal, or with carbonate of barytes, were exposed to a strong heat, large quantities of a combustible gas were extricated, which he supposed to be heavy

inflammable air, or carburetted hydrogen. He considered this as a strong argument against the modern theory of the formation of water; as, from the dryness of the ingredients, which were previously exposed to a red heat, and mixed and experimented upon immediately, and the quantity evolved, it could not be accounted for upon the supposition of the decomposition of water. This objection was successfully combated by Mr. Cruickshank showing that the air did not contain hydrogen, but was an oxide of carbon. It is equally procured from the oxides of other metals, and charcoal; but in proportion to the facility with which these give up their oxygen, the carbon is more or less saturated with it; so that the product is a mixture of carbonic acid gas, and carbonic oxide, the proportion of the former decreasing as the process is continued.

The carbonic oxide gas, freed from carbonic acid by washing with lime-water, is very little lighter than atmospheric air. It does not explode, when fired in atmospheric air, but burns with a blue lambent flame: with oxygen gas it detonates. It is noxious to animals. Water absorbs about a fifth only of its bulk. It is not absorbed by the pure alkalies, and does not precipitate lime-water. If it be mixed with hydrogen gas, and passed through an ignited glass tube, its oxygen unites with the hydrogen to form water, and charcoal is deposited. De Saussure, jun. however ascribes this appearance of carbonaceous matter lining the tube, to the action of the hydrogen on the lead in the glass, as he produced it by hydrogen alone with a glass tube; and could not by hydrogen and carbonic oxide in a tube of porcelain. The purest oxide of carbon is obtained, by passing the carbonic acid gas through red hot charcoal.

Gas, *hydrogen*. This is generally obtained from the reverse of the process for the decomposition of water. Iron moistened with water becomes oxided, by decomposing the water; but this process is very slow. If the vapour of water be passed through a tube containing iron wire kept at a red heat, the decomposition will go on with much more celerity. But the readiest method is to employ an acid, as the sulphuric, diluted with five or six times its weight of water, poured on iron filings or turnings, or on zinc in small pieces. Zinc affords it the purest, as that from iron is apt to be contaminated with carbon. Muriatic acid diluted with twice or thrice its weight of water, may be employed, but it is less œconomical.

Hydrogen gas is the lightest of all ponderable substances, particularly if received over quicksilver, and freed from any humidity which it may contain by exposure to any substance that attracts water strongly. When perfectly dry it is free from smell, but when it contains moisture it is slightly fœtid. Though highly inflammable, it extinguishes burning bodies if completely enveloped in it without the contact of oxygen. It is incapable of supporting life, but does not appear to possess any directly noxious quality, as it may be breathed for several respirations, or even nearly a minute. Fired, in combination with oxygen, it explodes very loudly; but if kindled as it escapes from the extremity of a capillary tube into the atmosphere, it burns calmly, with a white flame, the colour of which, however, may be varied by different substances dissolved in the gas. It is thus the philosophical fireworks without smoke or smell are formed. If a tube of glass, metal, or any elastic material be held over a jet of inflamed hydrogen gas, musical tones will be produced, varying in depth and strength, according to the length, diameter, and material of the tube. A glass jar has a similar effect, but it must not be too wide, or so narrow as to extinguish the flame. Dr. Higgins first discovered this property.

A very high temperature is generally considered as necessary to produce the combination of hydrogen and oxygen. Biot compressed the two gases together in the syringe of an air-gun; they took fire, exploded violently, and burst the syringe; but here the temperature was sufficiently increased by the pressure. A gentleman of Orkney, however, introduced nearly equal quantities of the two gases into a glass jar over mercury, which stood in a room without fire, and with little light, from the beginning of January to the end of May, when he found, that of twelve cubic inches, three and a half had disappeared. The residuum was still a mixture of the two gases.

The chief practical application of hydrogen gas is for the filling air-balloons.

Gas, *hydrogen arseniated*. Scheele, dissolving tin in arsenic acid, observed the extrication of an inflammable gas, holding arsenic in solution. Proust afterwards obtained it by digesting arsenious acid and zinc in diluted sulphuric acid. It may be

procured likewise by treating arsenious acid, or arsenic and iron filings, or arsenic and tin filings with muriatic acid; but still better by treating four parts of granulated zinc and one of arsenic, with sulphuric acid diluted with twice its weight of water.

This gas is insoluble in water; does not render lime water turbid; mixed with atmospheric air no diminution of bulk ensues, but the mixture, when fixed, detonates loudly, and deposits metallic arsenic; it has an alliaceous smell; it extinguishes burning bodies, and is fatal to animals; it is decomposed by oxygenated muriatic acid gas. If a lighted taper be immersed in a phial of this gas, it is instantly extinguished; but the gas burns at the mouth of the phial with a lambent white flame, which diffuses white fumes of arsenious acid. If it be inflamed in a phial with a small orifice, the flame gradually descends to the bottom of the phial, which becomes coated with crystallized metallic arsenic. Two parts of this gas, with one of oxygen, will explode loudly, and the products are water and arsenious acid; soap bubbles made with a mixture of these gases, explode with a blueish white flame. Equal parts of the gases explode with a much more vivid flame, but less noise. A stream of this gas, burned in a large receiver filled with oxygen, emits a blue flame of uncommon splendour. According to Tromsdorff's calculation, a cubic inch of the gas contains about a quarter of a grain of the arsenic. Its specific gravity is rather more than half that of atmospheric air.

Gas, *carburetted hydrogen.* There are several varieties of this gas, the hydrogen holding different proportions of carbon in solution, according to the process by which it is obtained.

The gas of stagnant water, which may be procured by stirring the mud at the bottom with a stick, and collecting the gas, as it rises in bubbles, in an inverted bottle, is this compound, as is also the fire damp of coal mines. The vapour of water passed through a tube containing ignited charcoal, consists of this gas and carbonic acid, which may be separated by agitating the mixture with lime diffused in water. The vapour of ether, or of alcohol, passed through a red hot tube of porcelain, coated with clay, affords the same products. If three parts of concentrated sulphuric acid, and one of alcohol, be distilled in a glass retort with a gentle heat, a carburetted hydrogen comes over. This is distinguished by the name of olefiant gas, from its property of forming an oil on coming into contact with oxygenated muriatic acid gas. If five measures be mixed with six of the oxygenated muriatic gas, as rapid a diminution takes place as when nitrous and oxygen gases are added to each other, and a thin film of oil forms on the surface of the water.

Mr. Henry examined these and some other varieties, as well as pure hydrogen, with a particular view to the light they were capable of affording, and the following are his tabulated results:

GASES.	Oxygen gas required to saturate 100 measures.	Measures of carbonic acid produced.
Pure hydrogen	50 to 54	0
Gas from moist charcoal	60	35
—— —— oak	54	33
—— —— dried peat	68	43
—— —— coal	170	100
—— —— lamp oil	190	124
—— —— stagnant water	200	100
—— —— wax	220	137
Pure olefiant gas	284	179

The light evolved appeared to be in proportion to the oxygen consumed, so that the first four in the list yielded very little; but the last much exceeded all the rest. Its detonation with oxygen gas too is more violent than that of any other inflammable gas, .03 of a cubic inch, with .17 of oxygen gas, being sufficient to burst a strong glass tube.

About the year 1792, Mr. Murdoch made various experiments on the gas from coal, peat, and other substances, as a substitute for lamps and candles, both as fixed and as moveable lights, and in 1793 he applied it to the purpose of lighting the extensive manufactory at Soho. Light was procured by the same means several years ago at the ovens in Shropshire, for preparing coke and tar on Lord Dundonald's plan. And six or seven years since a projector at Paris lighted up his house and gardens, and proposed to light the streets of the city in a similar way.

The varieties above enumerated differ in specific gravity, the olefiant gas being the heaviest, and that from charcoal the lightest. They differ likewise in the quantity absorbed by water, which takes up one-eighth its bulk of olefiant gas, one-sixty-

fourth of that from stagnant pools, and still less of the others.

Gas, *phosphuretted hydrogen.* This may be procured by boiling in a retort a little phosphorus, with a solution of pure potash. The phosphorus should be first melted under water in the retort, which is to be emptied when the phosphorous has congealed, and then filled with the alkaline solution. Of this a sufficient portion is to be displaced by hydrogen gas. Or one part of phosphorus, cut into very small pieces, and two of finely granulated zinc, may be put into ten parts of water, and six parts of concentrated sulphuric acid added; the gas is disengaged in small bubbles, which cover the whole surface of the fluid, and take fire on reaching the air, so as to form by their succession a well of fire.

If two parts of phosphuret of lime, broken into pieces the size of a pea, and one of hyperoxymuriate of potash be put into an ale glass, or a Florence flask; the vessel be filled with water, and six or eight parts of concentrated sulphuric acid be poured in through a long-necked funnel reaching to the bottom; as soon as decomposition commences, flashes of fire will dart from the surface, and the bottom of the vessel will be illumined with a beautiful green light.

When phosphuretted hydrogen gas is suffered to escape into the air, as it issues from the retort it takes fire, and a dense white smoke rises in the form of a horizontal ring, enlarging its diameter as it ascends. It detonates when mixed suddenly with oxygen, oxygenized muriatic acid, or nitrous oxide gas. By standing it loses its property of spontaneous ascension, the phosphorus being deposited on the inner surface of the vessel containing it.

Phosphuretted hydrogen gas may be dissolved in about four times its bulk of distilled water, at 44° Fahrenheit, and imparts to it a bitter taste, and strong unpleasant smell. This solution speedily converts the oxides of lead and mercury, and nitrate of silver into phosphurets of those metals. Nitrates of lead, mercury and arsenic, and sulphates of copper and iron, are acted upon by it more or less slowly; but some of the phosphurets then formed, are changed by standing some time into phosphates.

The ignis fatuus, or jack with a lantern, is supposed to be produced by this gas, arising from the putrefaction of animal substances in swampy places.

Gas, *sulphuretted hydrogen.* This gas, formerly termed hepatic air, may be obtained by adding dilute muriatic acid to a solution of sulphuret of potash or of soda, which evolves it with violent effervescence; or by pouring diluted sulphuric or muriatic acid on sulphuret of iron. Sulphur and iron mixed together with a little water likewise afford it by distillation.

Sulphuretted hydrogen is particularly characterised by its offensive smell, resembling that of rotten eggs. Like the other compounds of hydrogen it detonates if mixed with oxygen or atmospheric air, and then fired, and burns silently if inflamed as it comes into contact with them from a small aperture. If three parts of it be mingled with two of nitrous gas, the mixture burns with a yellowish green flame.

This gas is decomposed by oxymuriatic acid gas, by sulphurous acid gas, or by being kept mixed with atmospheric air, and its sulphur is precipitated. If passed through ignited charcoal it is converted into carburetted hydrogen gas. It precipitates all metallic solutions, except those of iron, nickel, cobalt, manganese, titanium, and molybdæna. It tarnishes silver, mercury, and other polished metals, and immediately blackens white paint.

This gas is absorbed by water, which at 55° takes up .86 of its bulk, and at 85° only .78. The solution exposed to the air becomes covered with a pellicle of sulphur; and deposits sulphur even in well corked bottles. A few drops of nitric or nitrous acid likewise precipitate the sulphur.

It is remarkable that sulphuretted hydrogen, which contains no oxygen, consisting, according to Thenard, of 29 hydrogen, and 71 sulphur, should possess the properties of an acid, reddening litmus paper, and uniting with the alkalies and all the earths, except alumina and zircon. These compounds are soluble, and most of them are susceptible of crystallization. They are at first colourless, but by exposure to the air become green, or of a greenish yellow, and desit sulphur. At length, however, the solution again becomes colourless, and the base is found ultimately converted into a sulphate. Acids disengage their sulphuretted hydrogen gas. Vauquelin, having lixiviated a considerable quantity of soda manufactured in France, found, after some weeks, a white transparent salt, crystallized in tetrahedral prisms, terminated by quadrangular or octangular pyramids. Its taste was acrid and intolerably bitter, and it had a slight hepatic smell. It did not precipitate any of the earthy salts, except those of

alumina, zircon, and yttria. Some of the German chemists have classed it as an acid, by the name of the hydrothian.

The waters called sulphureous, or hepatic, as those of Harrowgate, are solutions of this gas. They are recommended as alteratives in cutaneous affections; against worms, in gout and jaundice, and as deobstruents; but they are said to have been very injurious in dropsy.

Gas, *muriatic acid.* Muriatic acid exists in a separate state only in the form of gas, but its attraction for water is so strong, that it can be received and confined only over mercury. According to Kirwan, water absorbs rather more than 420 times its bulk, and is augmented by it about one third: in Dr. Thomson's experiments it took up 515 times its bulk at 60° Fahrenheit. It liquifies ice very rapidly, and the temperature is lowered. It has a pungent smell, is fatal to animals, and extinguishes flame, first imparting to it a greenish tinge. Its bulk is increased by a succession of electric shocks, which Mr. Henry has shewn to arise from the decomposition of water, of which he infers from his experiments 60 grains hold 1.4 in solutions. On its coming into contact with atmospheric air, a white cloud is produced. Brisson gives its specific gravity, atmospheric air being 1000, at 1430, Henry at 1730, Kirwan at 1929. For its other properties see Muriatic Acid.

Gas, *oxygenized muriatic acid.* This gas, which is a compound of the preceding with oxygen, presents another anomaly in the theory of acidification; it was observed, that sulphuretted hydrogen resembles an acid in many of its properties, though it contains no oxygen; and we here find the radical of an acid, which with a certain proportion of oxygen ranks among the most powerful, so much weakened in its properties, as even to be denied by some a place among the acids.

This gas is not invisible, as it has a greenish yellow colour. It has a pungent, suffocating smell, and is very injurious to the lungs; it extinguishes burning bodies; a temperature of 40° Fahrenheit reduces it to a liquid form. Mr. Northmore condensed nearly two pints in a receiver of the capacity of 2¼ inches, in which state it was a yellow fluid, so extremely volatile as to evaporate the instant the screw of the receiver was opened. A pint of this gas being injected upon half a pint of oxygen, the result was a thicker substance, that did not evaporate so soon, and left a yellowish mass behind. Nitrogen in the same proportion gave a still thicker substance, and of a deeper yellow. In both these experiments much of the grease of the machine was carried down. Into a receiver, of three inches capacity, a pint of carbonic acid gas was pumped, and then rather more than a pint of oxygenized muriatic acid gas: the result was of a sap green colour, but still elastic. Two pints of the gas with a pint of hydrogen was of a light yellow green, without any fluid, and highly destructive of colours.

This gas acts powerfully on various combustible bodies. If four parts of it, and three of hydrogen be put into a bottle closely stopped, inverted, with its mouth under water, and the stopple be taken out in this situation after they have thus stood twenty-four hours, nearly the whole of the gas will have disappeared, and the remainder will be absorbed by the water. The hydrogen may be combined at once with the oxygen of this gas by the electric spark, which causes them to detonate. Phosphorus takes fire spontaneously in oxygenized muriatic acid gas; so do perfectly dry powdered charcoal of beech wood, and almost all the metals in fine filings, or very thin leaves. About a cubic inch of the gas, is sufficient for a grain of metal; the bottom of the vessel should have a little sand on it, to prevent it from cracking; and the temperature should not be less than 70°. If a drachm of good ether be thrown into a three pint vessel filled with this gas, and the mouth covered with a piece of paper, a circulating white vapour will arise in a few seconds, which will soon be followed by an explosion with flame.

For the rest of its properties see Muriatic oxygenized acid. Nitric acid gas, and Nitric *acid.*

Gas, *nitric oxide,* or nitrous gas. We owe our first knowledge of this elastic fluid to Dr. Priestley, who called it nitrous air. It may be formed by passing ammoniacal gas through the black oxide of manganese heated red hot in an earthern tube; but it is most easily obtained by abstracting a portion of its oxygen from nitric acid. For this purpose fine copper wire, or copper filings, may be put into a retort, with an equal weight of nitric acid, diluted with four or five parts of water, and moderate heat applied; or diluted only with an equal quantity of water, and no heat employed. After the atmospheric air is expelled from the retort, the gas that comes over may be received in the pneumatic apparatus. Other

metals might be employed for the same purpose, but mercury and copper appear to afford it in the greatest purity; and the latter is perhaps preferable, because the process goes on more regularly with it.

This gas is colourless, and somewhat heavier than atmospheric air. It is extremely deleterious, killing even insects very quickly, and destroying plants. Water deprived of air absorbs about one-ninth of its bulk of this gas, without acquiring any taste from it; and a boiling heat expels it again unchanged. If the water contain air, the gas is partly decomposed, and the absorption, though in reality greater, is apparently less, from the nitrogen evolved. Water impregnated with earthy salts, does not absorb so much; a solution of green sulphate, or green muriate of iron, however, absorbs it rapidly, and becomes dark brown, and almost opaque. When this is effected over mercury, the gas may be expelled unchanged by a moderate heat, or by placing the solution in a vacuum, though perhaps not the whole of it. Solutions of nitrate of iron, the sulphates of tin, and of zinc, and muriate of zinc, likewise absorb it.

Nitrous gas has no acid properties. It does not redden vegetable colours, but impairs them. It extinguishes the flame of a candle, or burning sulphur, and the phosphoric light of animal substances: but lighted charcoal continues to burn in it; lighted phosphorus burns in it with great splendour, though if not previously kindled it may be melted or sublimed in it, without taking fire; and Homberg's pyrophorus kindles in it spontaneously. Its most important property is its affinity for oxygen gas, on account of which it was employed by Dr. Priestley, as it still is by many, to ascertain the quantity contained in atmospheric air. See Eudiometer.

When mixed with oxygen gas red fumes arise, heat is evolved, and the two gases, if in due proportion and both pure, disappear, being converted into nitric acid.

This gas is soluble in nitric acid, and alters its properties in some measure, without, however, converting it into an acid, in a distinct state of oxygenation, as some had supposed.

Gas, *nitrous oxide*. This is the gaseous oxide of nitrogen, or of azote of some; a compound of nitrogen with a still less proportion of oxygen than the preceding gas. It is not to be obtained certainly with any purity, but by the decomposition of nitrate of ammonia. For this purpose nitric acid diluted with five or fix parts of water, may be saturated with carbonate of ammonia, and the solution be evaporated by a very gentle heat, adding occasionally a little of the carbonate, to supply what is carried off. The nitrate crystallizes in a fibrous mass, unless the evaporation has been carried so far as to leave it dry and compact. The latter at a heat between 275° and 300° sublimes without being decomposed; at 320° it becomes fluid, and is partly decomposed, partly sublimed: between 340° and 480° it is decomposed rapidly. The fibrous is not decomposed below 400°, but a heat above 450° decomposes it; at 600° a luminous appearance is produced in the retort, and nitric oxide, nitrous oxide, and nitrogen, mixed in various proportions, are evolved; at 700° or 800° an explosion takes place. It is best to perform the operation over an Argand's lamp, as the heat may thus be brought to the requisite degree speedily, and kept from going too far. It should be received over water, and suffered to stand an hour in contact with it, to free it from any nitrate of ammonia that may have been sublimed, as well as from any acid suspended in it. Dr. Pfaff recommends mixing very pure sand with the nitrate, to prevent the hazard of explosion; and observes, that it is particularly requisite it should not be contaminated with muriatic acid. One pound of the compact nitrate yields 4.25 cubic feet of gas, and a pound of the fibrous nearly five cubic feet.

The most singular property of this gas is its action on the animal system. Dr. Priestley had found, that it was fatal to animals confined in it. Mr. Davy first ventured to respire it, which he did to considerable extent. When breathed alone for a minute or two, and some have gone as far as four or five minutes, it generally produces a pleasant thrilling, particularly in the chest and extremities, frequently with an inclination to laugh, and sometimes an irresistible propensity to gesticulation and muscular exertion. The mind meanwhile is often totally abstracted from all surrounding objects. Sometimes its effects are not entirely dissipated for some hours; and it is remarkable, that, however strong they may have been, no sense of debility or languor is induced after they have subsided. On a few individuals, however, its effects have been unpleasant and depressing; in some it has produced convulsions, and other nervous symptoms; and on some it has had no sensible effect.

Indeed, not only different persons, but the same individual, will be variously affected by it, perhaps, at different times. Similar effects have been produced on those who have tried it abroad.

In debility arising from residence in a hot climate, and intense application to business, this gas has proved a complete remedy. It has given voluntary power over palsied parts while inhaled, and the subsequent application of other remedies has effected a cure. Dr. Pfaff has suggested its use in melancholia: but in some cases of this disease it has done no good, and in one harm.

GAS, *nitrogen or azotic.* Under the article ATMOSPHERE it has been observed, that about three fourths of our atmosphere consist of gas, unfit to maintain combustion, or support life. It is called nitrogen or azotic gas, and is a little lighter than atmospheric air. It is incapable of supporting life, or combustion, yet a small portion is absorbed in respiration. It is not inflammable, though it unites with oxygen in different proportions, forming nitrous oxide, when the oxygen is only .37, nitric oxide when it is .56, and nitric acid when .705. It is one of the most general elements of animal substances. With hydrogen it forms ammonia; and Fourcroy suggested, that it might possibly be the alkaligenating principle, though he confesses there are no facts in support of this conjecture; the name of alkaligen, therefore, which has been proposed for it, is certainly inadmissible. It dissolves small portions of phosphorus, sulphur, and carbon.

GAS, *oxygen.* This gas was obtained by Dr. Priestley in 1774, from red oxide of mercury, exposed to a burning lens, who observed its distinguishing properties of rendering combustion more vivid and eminently supporting life. Scheele obtained it in different modes in 1775; and in the same year Lavoisier, who had begun, as he says, to suspect the absorption of atmospheric air, or of a portion of it, in the calcination of metals, expelled it from the red oxide of mercury heated in a retort. Priestley called it dephlogisticated air; Scheele, from its peculiar property, fire air, a name before given it by Mayow, or empyreal air.

Oxygen gas, forms about a fourth of our atmosphere, and its base is very abundant in nature. Water contains .85 of it, and it exists in most vegetable and animal products, acids, salts, and oxides.

This gas may be obtained from nitrate of potash, exposed to a red heat in a coated glass or earthern retort, or in a gun barrel, from a pound of which, about 1200 cubic inches may be obtained; but this is liable, particularly toward the end of the process, to a mixture of nitrogen. It may also be expelled from the red oxide of mercury, or that of lead; and still better from the black oxide of manganese, heated red hot in a gun barrel, or exposed to a gentler heat in a retort with half its weight, or somewhat more, of strong sulphuric acid. To obtain it of the greatest purity, however, the hyperoxymuriate of potash is preferable to any other substance, rejecting the portions that first come over as being debased with the atmospheric air in the retort. Growing vegetables, exposed to the solar light, give out oxygen gas, so do leaves laid on water in similar situations, the green matter that forms in water, and some other substances.

Oxygen gas has neither smell nor taste. It is a little heavier than atmospheric air; under great pressure water may be made to take up about half its bulk. It is essential to the support of life; an animal will live in it a considerable time longer than in atmospheric air; but its respiration becomes hurried and laborious before the whole is consumed, and it dies; though a fresh animal of the same kind can still sustain life for a certain time in the residuary air.

Combustion is powerfully supported by oxygen gas: any inflammable substance, previously kindled, and introduced into it, burns rapidly and vividly. If an iron or copper wire be introduced into a bottle of oxygen gas, with a bit of lighted touchwood, or charcoal at the end, it will burn with a bright light, and throw out a number of sparks. The bottom of the bottle should be covered with sand, that these sparks may not crack it. Mr. Accum says, a thick piece of iron or steel, as a file, if made very sharp at the point where it is first kindled, will burn in this gas. If the wire, coiled up in a spiral like a corkscrew, as it usually is in this experiment, be moved with a jerk the instant a melted globule is about to fall, so as to throw it against the side of the glass, it will melt its way through in an instant, or if the jerk be less violent, lodge itself in the substance of the glass. If it be performed in a bell-glass, set in a plate filled with water, the globules will frequently fuse the vitreous glazing of

the plate, and unite with it so as not to be separable without detaching the glaze, though it has passed through perhaps two inches of water.

As oxygen gas appears to be a very powerful stimulus to the animal œconomy, it has been applied medicinally; and is reported to have been of great service in many cases of debility, palsy, nervous affections, scrofula, rickets, and even hydrocephalus.

Gas, *sulphurous acid*. When sulphur is burnt slowly, a gas arises, of a suffocating pungent smell, consisting of sulphur combined with oxygen in less proportion than is requisite to form sulphuric acid. This was known to the earlier modern chemists, and Stahl examined some of its combinations; Priestley showed it was permanently elastic; Berthollet pointed out its difference from the sulphuric acid; and Fourcroy and Vauquelin completed its examination.

In the mode above mentioned, it is very difficult so to regulate the combustion, as to obtain it free from sulphuric acid, which is formed when the sulphur burns with a certain degree of rapidity; so that it is commonly made by subtracting oxygen from sulphuric acid, by some other inflammable substance. The metals answer the purpose, but such as do not decompose water should be employed, otherwise more or less hydrogen will be evolved. Tin or quicksilver answers best; one part of which may be put into a retort, with two of concentrated sulphuric acid, and heat applied. It should be received over mercury, as water aborbs it, taking up thirty-three times its bulk.

This gas is above twice as heavy as atmospheric air: it kills animals very speedily, and extinguishes burning bodies. From this latter property it has been recommended, when a chimney is on fire, to throw a spoonful or two of flowers of sulphur into the grate. It whitens and gives lustre to silk, and is useful in bleaching woollens. Fresh prepared muriate of tin decomposes it, sulphur being deposited, and the muriate oxygenized. Mr. Northmore has condensed it by pressure: and Monge did the same, with the addition of artificial cold. According to Dr. Thomson, it consists of sulphur sixty-eight parts, oxygen thirty-two.

One hundred grains of water take up 5 grains of this gas, or 25 parts by measure; or, according to Dr. Thomson, 8.2 grains, equal to 33 times its volume. The solution has a pungent disagreeable odour, and an acid taste. It reddens some of the vegetable colours, such as that of litmus, or red cabbage; there are others, however, the colour of which it destroys, as that of the red-rose. The effect of the gas upon these colours is similar.

The saturated solution allows the gas to escape at a very moderate heat, and by boiling, the greater part is expelled, though the liquor remains acid, apparently from the presence of sulphuric acid. It is singular that it is not expelled by freezing; but still remains combined with the ice, and renders it so heavy that it sinks in water. This fact shews that this gas has, comparatively with others, little tendency to pass into the aeriform state. The freezing of the solution takes place at a few degrees below 32.

When two parts of the gas are mixed with one part of oxygen gas, if the mixture is kept over mercury, they do not act on each other. But if a small portion of water is introduced, they gradually combine and form sulphuric acid, a fact explained by Mr. Murray, on the supposition that the water exerts a strong disposing affinity to this acid, or to speak more intelligibly, according to the explanation of disposing affinity given under our article Chemistry, the water attracks the sulphureous gas, and by depriving it of its state of elastic fluidity, renders it capable of more readily uniting with the oxygen, which is also effected by a like action of the water; and as these combine into sulphuric acid, which is more soluble than the sulphureous, the process is still more facilitated, and goes on progressively until the effect is completed. By passing a mixture of oxygen gas, and sulphureous acid gas, through a tube heated to redness, they instantly combine, and sulphuric acid is formed.

This acid combines with facility with the alkalies, forming salts denominated sulphites, which differ considerably from the salts formed by the sulphuric acid. Their taste is sulphureous; they are decomposed by a high temperature, their acid being either expelled, or a portion of sulphur being driven off, in which case they become sulphates; they are also decomposed by the greater part of the acids, and then the sulphureous acid is disengaged with effervescence. The alkaline sulphites are more soluble than the sulphates in water, the earthy sulphites less so. All these salts are converted into sulphates by exposure to the atmospheric air, or by the action of any substance capable of affording them oxygen. They suffer this change, for example, by deflagration with nitre. See Sulphureous Acid.

TABLE,

Shewing the absolute Weights and specific Gravities of Gases, and the Quantity of each absorbed by Water.

Temperature 60° Fahrenheit, Barometer 29.8.

B. Brisson; Cr. Cruickshank; D. Davy; Dal. Dalton; Dei. Deiman; H. Henry; K. Kirwan; S. Shuckburgh; T. Thomson; Th. Thenard; Tr. Tromsdorff.

KIND OF GAS.	Weight of 100 cubic inches in grains.	SPECIFIC GRAVITY.			Number of cubic inches absorbed by 100 inches of water.	
		Water, the Standard at 1000.	Air, the Standard.	Authority.		
Nitric acid	76.	3.	2425	D.		
Sulphurous	70.215	2.75	2240	K.	3300.	T.
Vapour of ether	62.1*	... ..	2250	Dal.		
Muriatic acid	59.8	......	1929	K.		
Vapour of alcohol	51.5†	......	2100	Dal.		
Nitrous oxide	50.1	1.985	1615	...	86.	H.
Carbonic acid	46.5	1.84	1500	K.	108.	H.
Ditto......Ditto	45.5	1.802	1470	D.		
Muriatic acid	44.7?	1.765	1430	B.	51500.	T.
Sulphuretted hydrogen	38.17	......	1231	Th.		
Nitric oxide	37.	1.465	1193	K.	5.	H.
Nitric oxide	34.3	1.36	1105	D.		
Oxygen gas	34.74	1.39	1127	D.		
Sulphuretted hydrogen	34.286	1.36	1142	K.	108.	H.
Oxygen gas	34.	1.35	1103	K.	3.7	H.
Atmospheric air	31.	1.2279	1000	S.		
Azotic gas	30.535	1.21	985	K.	1.53	H.
Azotic gas	30.45	1.20	980	D.		
Carbonic oxide	30.	1.185	967	Cr.	2.01	H.
Olefiant gas	28.18	......	905	Dei.	12.5	Dal.
Hydro carburet from stagnant water	20.66	......	666	Dal.	1.40	H.
Ditto from coal	20.2	......	650	Dal.		
Ditto from ether	20.	......	645	Cr.		
Ammonia	18.16	0.715	585	K.		
Ditto	18.	0.713	580	D.	47500.	D.
Arsenicated hydrogen gas	...	0.6499	529	Tr.		
Hydro carburet, from alcohol	16.	......	516	Cr.		
Ditto from water over ignited charcoal	14.5	......	468	Cr.		
Hydrogen gas	2.613	0.1031	84	K.	1.61	H.
Phosphuretted hidrogen.	...	.....	...	...	2.14	H.

* Of temperature 100° Fahrenheit, and force = 30 inches of Mercury.

† Of temperature 190° Fahrenheit, and force = 30 inches of Mercury.

GASSENDI, (Peter), in biography, a very eminent philosopher and mathematician, and one of the most illustrious ornaments of France, in the seventeenth century, was born in the year 1592, at Chantersier, about three miles from Digne, in Provence. He afforded early evidence that he possessed a lively and inquisitive genius, and a happy memory, which determined his parents, though they were but in moderate circumstances, to bestow upon him the best education in their power. When he was only four years of age, in consequence of the pious impressions which had been made on his mind, he was accustomed to act the preacher among his playmates; and soon afterwards he began to discover his taste for astronomy, by taking delight in gazing at the moon and stars, when the atmosphere was unclouded.

The pleasure which he took in contemplating the heavens, often led him to retire to unfrequented spots, where he might feast his eyes without being disturbed; by which means his parents were frequently obliged to seek for him under anxiety and apprehensions for his safety. When he was of a proper age to be sent to school, he was placed under the instructions of an excellent master at Digne, where he made a rapid progress in the knowledge of the Latin tongue, and also acquired a pre-eminence over his school-fellows in rhetorical exercises. Afterwards he was sent to study philosophy for two years, under an able professor at Aix; and at the expiration of that period returned to his father's house at Chantersier.

He had not been long at home, however, before he was invited to teach rhetoric at Digne, when not quite sixteen years of age; and about three years afterwards he was appointed to fill the vacant chair of philosophy, in the University of Aix. During his residence at Digne, he had sedulously prosecuted his studies in the learned languages, mathematics, and astronomy, and after a diligent examination of the different systems of philosophy among the ancients, embraced that of Epicurus, of which he afterwards proved himself the most ingenious defender in modern times. When he entered upon his philosophical professorship at Aix, notwithstanding that the authority of Aristotle was still acknowledged in almost all the public schools, Gassendi, after the examples of Vives, Ramus, and others, ventured publicly to expose the defects of his system. The lectures which contained his censures of the Aristotelian philosophy, delivered in the indirect form of paradoxical problems, were published under the title of "Exercitationes Paradoxicæ adversus Aristotelem." This work, which gave great offence to those who still retained their predeliction for scholastic subtlety, obtained the author no small degree of reputation with several learned men, particularly with Nicholas Peiresc, the president of the University of Aix, who determined to procure for him a situation in the church, in which he should be enabled to pursue his favourite studies at his leisure, and without any molestation. After Gassendi had entered into holy orders, through the interest of Peiresc, and Joseph Walter, prior of Vallette, he was promoted to a canonry in the cathedral church of Digne, and admitted to the degree of doctor of divinity; and afterwards received the appointment of warden, or rector of the same church. In consequence of these promotions, he resigned his professorship at Aix, and retiring to Digne, applied himself closely to his philosophical and astronomical pursuits.

Among his other works which he wrote in this place, was a second book of his "Exercitationes Paradoxicæ," intended to expose the futility of the Aristotelian logic. It was his first intention to pursue the plan still further; but the violent opposition which he met with from some of the zealous and powerful advocates for the authority of Aristotle, induced him to desist from all direct attacks upon his philosophy. Still, however, he professed his attachment to the system of Epicurus, and defended it with great learning and ability.

From Lucretius, Laertius, and other ancient writers, he undertook to frame a consistent scheme of Epicurean doctrine, in which the phenomena of nature are immediately derived from the notion of primary atoms. But he was aware of the fundamental defect of this system, and added to it the important doctrine of a divine superintending mind, from whom he conceived the first motion and subsequent arrangement to have been derived, and whom he regarded as the wise governor of the world. He strenuously maintained the atomic doctrine in opposition to the fictions of the Cartesian philosophy, which were at that time obtaining great credit; and particularly asserted in opposition to Des Cartes, the doctrine of a vacuum. On the subject of morals, he explained the permanent pleasure or indolence of Epicurus, in a manner

perfectly consistent with the purest precepts of virtue. In the year 1628, Gassendi, for the sake of extending his acquaintance with the learned, visited Holland, where his philosophical and literary merit soon procured him many admirers and friends. While he was in that country he wrote an elegant and judicious apology for his friend, the learned Mersenne, in reply to the censures of Robert Fludd, on the subject of the Mosaic philosophy. After his return to France, he continued his philosophical, and particularly his astronomical studies, pursuing with great care, a series of celestial observations, in order to complete his system of the heavens. Being called by a law-suit to Paris, he there formed an acquaintance with the men most distinguished for science and learning in that capital, and by his agreeable manners, as well as reputation, secured the esteem of persons of high rank and quality, and in particular of Cardinal Richelieu, and of his brother the cardinal of Lyons. Owing to the application and interest of the latter, in the year 1645, Gassendi was appointed regius-professor of the mathematics at Paris. This institution being chiefly intended for astronomy, our author read lectures on that science to crowded auditories, by which he acquired great popularity, and rose to high expectations. But the fatigues of that appointment were more than his strength, already reduced by too intense application, was able to bear; and having caught a cold, which brought an inflammation upon his lungs, he was obliged, in the year 1647, to quit Paris, and to return to Digne for the benefit of his native air. After having his health in some measure re-established by the intermission of his studies, in the year 1653, he retured again to Paris, where he published the lives of Tycho Brahe, Copernicus, Purbach, and Regiomontanus; and then resumed, with as much intenseness as ever, his astronomical labours. His feeble state of health, however, was now unequal to such exertions, which brought on a return of his disorder: under which, with the aid of too copious and numerous bleedings, he sunk in 1655, when in the sixty-third year of his age. A little before he expired, he desired his secretary to lay his hand upon the region of his heart; which when he had done, and remarked on the feeble state of its pulsation, Gassendi said to him, "You see how frail is the life of man!" which were the last words he uttered. He is ranked by Barrow among the most eminent mathematicians of the age, and mentioned with Galileo, Gilbert, and Des Cartes.

His commentary upon the tenth book of Diogenes Laertius, affords sufficient proof of his profound erudition, and his deep skill in the languages.

We have already mentioned his opposition to the philosophy of Des Cartes, by which he divided with that great man the philosophers of his time, almost all of whom were, either Cartesians or Gassendists. At one time a coolness took place between those two eminent characters, in consequence of irritating expressions which had escaped from both their pens, during the course of their philosophic warfare. The Abbé d'Estrees, afterwards Cardinal, with the design of bringing about a reconciliation between them, invited them both to dinner, in company with many of their common friends, among whom were father Mersenne, Roberval, the Abbé de Marolles, &c. At the time fixed, all the expected guests made their appearance, excepting Gassendi, who, during the preceding night, had been attacked by a severe complaint, which prevented him from venturing abroad. As the cause of his absence was explained after dinner, the Abbé d'Estrees, carried his whole company along with him to Gassendi's apartments, where they had the pleasure of hearing the two philosophers make mutual acknowledgments of their improper warmth and irritability, and generously declaring, that whatever difference in opinion might afterwards subsist between them, it should produce no unfavourable effect upon their friendship.

Gassendi was the first person who observed the transit of Mercury over the sun. Kepler had predicted that it would take place on the 7th of November, 1631. Gassendi, who was then at Paris, made due preparations to observe it, and after having for some time mistaken the appearance of that planet for a solar spot, became at length sensible of his error by the rapidity of its movement; and took care to calculate the time of its egress from the sun's disk, as well as its distance from the sun's vertical point.

From Gassendi's letters, it appears, that he was often consulted by the most celebrated astronomers of his time, as Kepler, Longomontanus, Snell, Hevelius, Galileo, Kircher, Bulliald, and others; and his labours certainly entitle him to a high rank among the founders of the reformed philo-

sophy. Gassendi possessed a large and valuable library, to which he added an astronomical and philosophical apparatus, which, on account of their accuracy and worth, were purchased by the Emperor Ferdinand III. and afterwards deposited, with other choice collections, in the Imperial library at Vienna. The MSS. which he left behind him, and the treatises formerly published by himself, were printed together, accompanied by the author's life, and published by Sorbiere, in six volumes folio, 1658. They consist in the philosophy of Epicurus; the author's own philosophy; astronomical works; the lives of Peiresc, Epicurus, Copernicus, Tycho Brahe, Purbeck, Regiomontanus, John Muller, &c. a refutation of the meditations of Des Cartes; and epistles, and other treatises.

GASTEROSTEUS, the *stickle-back*, in natural history, a genus of fishes of the order Thoracici. Generic character: body carinate on each side, somewhat lengthened, and covered with bony plates; dorsal fin single, with distinct spines between it and the head; ventral fins behind the pectoral, but above the sternum. There are thirteen species. G. aculeatus, or three spined stickle-back is found in almost all the fresh waters of Europe, and is about three inches long, and in the beginning of the summer displays the most beautiful combination of bright-red, fine olive green, and silvery whiteness. It is extremely active and rapid, and is particularly injurious in fish ponds, as it devours the spawn of the fish. It is highly voracious, and is reported to have swallowed in the space of five hours, seventy-four young dace, about a quarter of an inch in length. In the fens of Lincolnshire, these fishes appear in immense numbers, and have been frequently sold at the rate of a halfpenny per bushel. They have been often most successfully applied as manure for land.

GASTRIC *juice*; a fluid of the utmost importance in the process of digestion. It does not act indiscriminately on all substances, nor is it the same in all animals, nor does it continue always of the same nature, even in the same animal, it changes according to circumstances. No certain facts have yet been established as to the nature of the gastric juice: it is however completely ascertained that it acts with a chemical energy in dissolving food: it attacks the surface of bodies, unites to the particles of them, which it carries off, and cannot be separated from them by filtration. It operates with more energy and rapidity the more the food is divided, and its action is increased by a warm temperature. The food is not merely reduced to very minute parts; its taste and smell are quite changed; its sensible properties are destroyed, and it acquires new and very different ones. This fluid does not act as a ferment, it is a powerful antiseptic, and even restores flesh already putrified. Two things are well known with respect to the substances contained in the stomach. 1. They contain phosphoric acid; and, 2. they have the power of coagulating milk, and the serum in the blood. What the coagulating substance is, has not been discovered, but it is supposed to be not very soluble in water, since the inside of a calf's stomach, after being steeped in water six hours, and then well washed, still furnishes a liquor on infusion which coagulates milk.

GASTROBRANCHUS, in natural history, a genus of fishes, of the order Cartilaginei. Generic character: mouth beneath, furnished with pectinal teeth, in a double row on each side; body eel-shaped, carinate beneath by a soft fin, two ventral spiracles. G. cœcus or the hag-fish, is about five inches in length, in the European seas, but, in those of India attains the length of a common eel. Its appearance is very similar to that of the lamprey. It is characterized by the circumstance of exhibiting no traces of the existence of such an organ as the eye. It is reported by naturalists, that the hag-fish will often enter the mouths of fishes fixed on the hook of the angler, and gnaw a passage through their bodies, devouring all but the bones and skin. Its substance is so highly glutinous, that a large vessel of sea water will, in a short time after the living cœcus is placed in it, become of the consistence of jelly.

GATE, in architecture, a large door, leading, or giving entrance into a city, town, castle, palace, or other considerable building: or a place giving passage to persons, horses, coaches, or waggons, &c.

GAVELKIND, a tenure or custom belonging to lands in the county of Kent, by which the lands of the father are, at his death, equally divided among all his sons; or the land of a deceased brother, in case he leaves no issue, among all the brethren. This is by some called antient soccage-tenure: the custom came from our Saxon ancestors, among whom the inheritance of lands did not descend to the eldest, but to all the sons alike; and the reason why it was retained in Kent is, because the Kentish

men were not conquered by the Normans in the time of William I.

The particular customs attending this tenure are, that the heir, at the age of fifteen, may give or sell his lands in gavelkind; and though the father is attainted of treason and felony, and suffers death, the son shall inherit. A wife shall be endowed of a moiety of the gavelkind-lands, of which her husband died seised, during her widowhood. Likewise a husband may be tenant by curtesy of half his wife's lands, without having any issue by her; but if he marries again, not having issue, he forfeits his tenancy.

GAUGE-POINT, of a solid measure, the diameter of a circle, whose area is equal to the solid content of the same measure. Thus, the solidity of a wine-gallon being 231 cubic inches, if you conceive a circle to contain so many inches, the diameter of it will be 17.15; and that will be the gauge-point of wine-measure. And an ale-gallon, containing 282 cubic inches, by the same rule, the gauge-point for ale-measure will be found to be 19.15. After the same manner, may the gauge point of any foreign measure be obtained; and from hence may be drawn this consequence, that when the diameter of a cylinder, in inches, is equal to the gauge-point of any measure, given likewise in inches, every inch in length thereof will contain an integer of the same measure, *e. gr.* in a cylinder whose diameter is 17.15 inches, every inch in height contains one entire gallon in wine measure; and in another, whose diameter is 18.95 inches, every inch in length contains one ale-gallon.

GAUGER, a king's officer, who is appointed to examine all tuns, pipes, hogsheads, and barrels, of wine, beer, ale, oil, honey, &c. and give them a mark of allowance before they are sold in any place within the extent of his office.

GAUGING, is the art of ascertaining the contents of casks, vats, and other regularly formed vessels, either in wine measure, which has 231 cubic inches to the gallon; in ale measure, which has 282 to the gallon; or in corn measure, which has 2150.42 cubic inches to the bushel. To find the contents of a vessel of a rectilinear form, you must ascertain the number of square inches on its surface, which being divided by the foregoing numbers (according as you use wine, ale, or corn measure,) will give the contents in gallons. But in this we suppose the vessel to be only one inch in depth; if more, the number of inches from the surface to the bottom must become a second agent in the calculation. Thus, if a cooler be a parallelogram of 250 inches long, and 84.5 broad, these measurements being multiplied together, will give an area of 21,125 inches, which being divided by 282, the number of inches in an ale gallon, the result will be 74.9 gallons: or if the product had been divided by .003546, the quotient would have been 74.90925, which is much the same. We have in this case supposed the area to have perpendicular sides, only one inch in depth. If the sides be six inches deep, the foregoing result, *viz.* 74.9, should be multiplied by 6; which would then give 449.4 gallons to be the measurement of the cooler. Where the sides shelve in, as in most tubs, or project out, as in bell casks, regularly increasing or decreasing from the top to the bottom, the whole length at top, and the whole length at bottom must be added together, and be halved so as to give the medium length; and the same to find a medium of the two breadths at top and bottom. These mediums being multiplied together will give an area, which being multiplied by the depth in inches will shew the true contents, in either wine, ale, or corn measure, according to the divisor used. When the bottom shelves equally, the measurement at the centre will be a true medium; but if the bottom is uneven and irregular, you must take various measurements in different parts; then add the whole together, and divide by the number of measurements, or dips, and the quotient will, in general, be a fair medium. If the vessel is triangular, pentagonal, or anywise polyangular, the area must be ascertained by the ordinary rules in GEOMETRY, which see.

In circular vessels you must multiply the square of the diameter by .002785 for ale, or .003399 for wine: divide the former measure by 359.05, the latter by 294,12, and the quotients will be ale or wine gallons respectively.

Where you have an oval vessel to measure, ascertain the transverse or longest diameter, and the conjugate, or shortest diameter; multiply them together and divide as above.

Prismatic vessels are measured according to the first explanation, and frustrated or pyramidical vessels are disposed of in the same manner as those whose side or sides regularly augment, or *vice versa*. Truncated cones, likewise, come under the same rule; only treating their terminations as circles, instead of computing them as squares, or

rectilinear bases. The following very easy mode of ascertaining the contents of a conic frustrum is given by the ingenious Newton. Multiply each diameter (*i. e.* of top and bottom) by itself; then the one by the other, and the aggregate of those products by the altitude; multiply also the last product by 78539, (the superficial content of a circle whose diameter is 1000); a third part of the product is the measure of the frustrum.

Therefore, when vessels have their sides composed of straight ribs, proceeding in right lines from one to the other end of the conic frustrum, the measurement is easily made; thus we may, without difficulty, ascertain the contents of great coppers, mashing-tubs, corn-binns, and a great variety of similar vessels. But we rarely see casks of any description formed by the union of two frustrated cones; their usual shape is more spheroidal; that is, they have an arched or swelling course from the bung to the chine or end; consequently these contain more than such as are truly conical. This occasions the necessity for allowing something for the bulge or swell, and of taking the diameter at the centre, between the bung and the chine, which diameter will give a true medium. The thickness of the cask may easily be ascertained by aid of calibre compasses applied to the proper part. The length of the cask may be measured internally, by putting a rod or wand in at the tap hole, and the internal diameter may be taken in a similar way at the bung; but such can only be done when the cask is empty, or, at least, opened for the purpose: whereas casks that are filled and sealed must often be measured; for this purpose the calibre compasses are extremely useful, since they embrace the outside measure. To correct the computation, we must usually allow an inch and a half in the whole length, and the same in the whole diameters at the bung and chine, thus exteriorly taken, for the thickness of the cask itself. This deduction being made, we must compute according to the form or swell of the staves. If they be much raised, we multiply the difference between the diameter at the bung, and at the end, by .7; if less raised, or swelling, we multiply the difference by .65; if nearly straight, by .6, and if rectilinear, or truly conical, by .55: the product added to the diameter at the end, or head, will give a mean diameter. Suppose the diameter within the bung to be 32 inches, at the head 24, and that the length within be 40; the difference between 32 and 24 is 8, which, multiplied by .7, gives 5.6; add thereto the diameter at the head, 24, and the medium will be 29.6; multiply by the length 40, and divide by 359.05, and the quotient will be ale gallons 97.4. And thus, with the other multipliers, according to the apparent bulge or swell between the bung and the chine, and according to wine or ale measure.

To find the ullage, or quantity of liquor deficient in a cask, we have the following rule. Take the diameter at the bung, and ascertain the number of inches and parts that are dry, say that of 29 inches 13 be dry; also that the whole cask measures 80 gallons. Divide the dry inches 13 by 29, the bung diameter; the quotient will be .448; find the two first figures, .44, under V. S. in the annexed table, and its sequent will be .4238, to which add a proportional part for the 8, and the whole sequent will be .4343, which multiplied by the contents of the cask, will shew a deficiency of 34,661 gallons. This measurement, however, applies to cylinders only; if the cask be conical, you must find the mean diameter, which should be deducted from that at the bung; and noting half the difference, which is to be deducted from the wet inches and reserved. Then, as the mean diameter is to 100, so is the reserved difference to a versed line in the table; and if the segment (to be found in the table) be multiplied, as before shewn, into the contents, the product will be the quantity of liquor in the cask.

Example. Let the bung-diameter be 32, the mean-diameter 29.6, and the whole measure 97.4 gallons: say there be 19 inches wet:

From	32.0	From	90
deduct	29.6	take	1.2
remain	2.4	remain	17.8 reserved.
its half is	1.2		

Now as 29.6 is to 100, so is 17.8 to .60, the versed sine. The segment to 60 is .6265; which multiplied by 97.4, the whole contents, the product gives 61 gallons of liquor remaining. By working upon the dry inches, you would have found the ullage, or deficiency.

While he continued in the pursuit of these studies, the professorship of astronomy in Gresham College, London, becoming vacant by the death of the ingenious Edmund Gunter, Mr. Briggs encouraged Mr. Gellibrand to become a candidate for that chair. Accordingly he proceeded to London, with strong testimonials in his favour from the President, Vice President, and Fellows of his College, and other active friends, and was chosen to fill that post by the electors, in the month of January, 1626. From that time he lived, as he had done before, in a close intimacy with Mr. Briggs, who took great pleasure in communicating to him his mathematical opinions and discoveries, and at the time of his death confided to him the task of completing his "British Trigonometry," which he did not live to finish. While Mr. Gellibrand was preparing that work for the press, he was cited, together with his servant William Beale, into the High Commission Court, by Doctor Laud, then Bishop of London, on account of an almanac for the year 1631, which Beale had published with the approbation of his master. In this almanac, the Popish saints usually put into the calendar were omitted, and the names of other saints and martyrs, mentioned in "Fox's Acts and Monuments of the Church," were inserted, as they stood in Fox's calendar. This circumstance gave great offence to the haughty prelate, and determined him to prosecute them for a measure which he considered to be an unequivocal evidence of their Puritanism. But when their cause came to a hearing, by shewing that what they had done was no innovation, and pleading that they had no ill intention, they were acquitted by Archbishop Abbot, and the whole court, Laud only excepted; which was made an article of accusation against the last-mentioned prelate at his own trial. This prosecution proved the means of retarding the publication of Mr. Briggs's work; but when Mr. Gellibrand had escaped from the vengeance of Laud, he again applied to the completion of his friend's design, and having added to it a preface and the application of the logarithms to plane and spherical trigonometry, &c. constituting the second book of the work; the whole was printed at Gouda in Holland, under the care of Adrian Vlacq, in 1636. It was entitled, "Trigonometria Britannica, sive de Doctrina Triangulorum, Libri duo, &c." folio.

Mr. Gellibrand, however, though an industrious mathematician, had not sufficient comprehension of mind to admit the evidence, which Galileo had lately produced, in support of the Copernican system. This appears from the account which he has given of a conversation which he had, when he went over to Holland on the business of printing the Trigonometry, with Lansberg, an eminent astronomer in Zealand, who insisted on the truth of that system. "This which he was pleased to style a truth," says our author, "I should readily receive as an hypothesis, and so be easily led on to the consideration of the imbecility of man's apprehension, as not able rightly to conceive of this admirable opifice of God, or frame of the world, without falling foul of so great an absurdity. Yet, sure I am, it is a probable inducement to shake a wavering understanding."

From Mr. Gellibrand's situation at Gresham College, and his intercourse with the lovers of mathematical studies, he had an opportunity of contributing some pieces, mentioned below, to the improvement of navigation, which science would probably have been farther benefited by him had he not been immaturely carried off by a fever in 1636, when in the fortieth year of his age. That his mathematical knowledge was considerable, and usefully applied, is sufficiently apparent from the treatises which he left behind him, and the estimation in which he was held by the most respectable men of science among his contemporaries, both at Oxford and London. But he is entitled more to the praise of close and unwearied industry than of invention or genius. Besides his part of the "Trigonometria Britannica," he was the author of "An Appendix concerning Longitude," subjoined to Captain Thomas James's Voyage for the Discovery of the North West Passage, 1633, quarto; "A Discourse, mathematical, on the variation of the Magnetic Needle, together with the admirable diminution lately discovered," annexed to Wright's "Errors in Navigation Detected, &c." 1635, quarto; "A Preface to the Sciographia of John Wells, of Brembridge, Esq." 1635, 8vo; "An Institution, trigonometrical, explaining the doctrine of plane and spherical Triangles, after the most exact and compendious way, by Tables of Sines, Tangents, &c. with the application thereof to questions of Astronomy and Navigation," 1634, octavo; and afterwards republished with enlargements by William Leybourn, 1652, octavo: "An Epitome of Navigation, with the necessary tables, &c. and "An

in proportion to the quantity of wood scooped from the interior face.

GAULTHERIA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Bicornes. Ericæ, Jussieu. Essential character: calyx, outer two-leaved, inner five-cleft; corolla ovate; nectary with ten-dagger points; capsule five-celled, covered with the inner calyx, now become a berry. There are two species.

GAURA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character: calyx four-cleft, tubulous; corolla four-petalled, rising towards the upper side; nut inferior, one-seeded, four-cornered. There is but one species.

GAUZE, in commerce, a thin transparent stuff, sometimes woven with silk, and sometimes only of thread. In preparing the silk for making gauze it is wound round a wooden machine six feet high, in the middle of which an axis is placed perpendicularly, with six large wings: on these the silk is wound on bobbins by the revolution of the axis; and, when it is thus placed round the mill it is taken off by means of another instrument, and wound on two beams. This is then passed through as many small beads as it has threads, and is thus rolled on another beam in order to supply the loom. Gauzes are either plain or figured; the latter are worked with flowers of silver or gold, on a silk ground; and are chiefly imported from China. Gauzes of excellent quality have, of late years, been manufactured at Paisley.

GAZELLA. See ANTELOPE.

GAZETTE, a newspaper, or printed account of the transactions of all the countries in the known world, in a loose sheet, or half sheet. This name is with us confined to that paper of news published by authority.

The first gazette in England was published at Oxford, the court being there, Nov. 7, 1665. On the removal of the court to London the gazette was published there. In this work are recorded all commissions and promotions in the army; all state appointments of consequence, with a variety of matters interesting to men of business and others.

GAZONS, in fortification, pieces of fresh earth, covered with grass, and cut in form of a wedge, about a foot long, and half a foot thick, to line the outsides of works made of earth, as ramparts, parapets, &c.

GELATINE, in chemistry, is one of the constituent parts of animal substances. Glue, well known in many of the mechanical and other arts, is gelatine in a state of impurity, and may be obtained by repeatedly washing the fresh skin of an animal in cold water, afterwards boiling it, and reducing it to a small quantity by slow evaporation, and allowing it to cool. It then assumes the form of jelly, and becomes hard and semi-transparent. Gelatine has neither taste nor smell; it is soluble in hot acids and alkalies; but there is no action between any of the earths and this substance. Some of the metallic oxides and salts form precipitates with gelatine in its solution in water, and the compound thus formed is insoluble. Gelatine forms a copious white precipitate with tan, which is brittle and insoluble in water, and is not changed by exposure to the air. It is composed of carbon, hydrogen, azote, and oxygen, with small portions of phosphate of lime and of soda. It is a principal part both of the solid and fluid parts of animals, and is employed in the state of glue, size, and isinglass. See GLUE.

GELD, in our old customs, a Saxon word, signifying money, or tribute: also a compensation for some crime committed. See GILD.

GELLIBRAND, (HENRY) an industrious English mathematician and astronomer, was born at London in the year 1597. When he was eighteen years of age he was admitted a commoner of Trinity College, in the university of Oxford, where, in the year 1619, he took his degree of B.A. At that time, Anthony Wood says, "He was esteemed to have no great matter in him;" but afterwards he conceived a strong inclination for the mathematics, upon accidentally hearing one of Sir Henry Saville's lectures in that science, and applied to it with considerable diligence and success. Having taken orders, he settled for some time as a curate at Chiddingstone in Kent; but his passion for mathematical studies determined him to quit that situation, and to return to the University, where he might uninterruptedly pursue the bent of his mind, supported by the moderate private patrimony which descended to him on the death of his father. His sole attention was now devoted to the mathematics, in which he made such proficiency, at the time of his taking his degree of M.A. in 1623, that he attracted the notice and friendship of several able mathematicians who flourished at that time, particularly of the celebrated Henry Briggs, then Savillian professor of geometry at Oxford.

of their hardness, transparency, and beauty, when cut and polished, are highly esteemed, and from their small size and scarcity, are valued at very considerable price. The gems have been placed among the siliceous fossils, as in some measure allied with them in external characters; and silex was supposed to be their principal ingredient. Bergman first shewed the error of this opinion, and proved, by analysis, that in the emerald, sapphire, topaz, ruby, and hyacinth, argil predominates; their other constituent principles, as discovered by his analysis, being silex, lime, and oxide of iron. Still, however, the old prejudice prevailed, and they have been generally ranked by mineralogists under the siliceous genus.

The specific distinctions of these fossils were not less obscure; they were perplexed by the distinctions of the jewellers, drawn from very vague notions: the colour, in particular, being the property in which the gems differ most obviously, and which frequently gives them their mercantile value, served as a ground of distinction: hence the ruby, the sapphire, and the topaz were considered as different, though essentially the same. Another circumstance added to the confusion thus introduced, was that, other fossils, bearing a resemblance to these gems, had been classed with them; but, being inferior in lustre, transparency, and hardness, in order to distinguish between them, the epithet oriental was applied to those which were most perfect; and, by this contrivance, fossils were classed under one name, and regarded only as varieties of one species, which were totally different. The Oriental and the Saxon topaz, for example, were regarded under this point of view, or as varieties of one species, to which the common name of topaz belonged, though they are fossils altogether distinct. From these two circumstances, fossils were separated which ought to have been associated, and others were connected, which were specifically different; and it has required much mineralogical discussion to disentangle the perplexity, and establish the proper species.

Romi de l'Isle threw the first ray of light on this subject, by disregarding the colour, and attending rather to the form of crystallization; in consequence of which he arranged together the principal gems named oriental, under the title of the oriental ruby. Werner also has placed them under one species, to which he gives the name of sapphire. Hauy has adopted the same arrangement, distinguishing the species by the name of télésie; and, more lately, Bournon has still farther extended the relations of these fossils, by connecting them with the corundum, a fossil which had been brought from India, and which, analysed by Klaproth, was found to be composed principally of argillaceous earth. This, having in general little transparency or lustre, Bournon names imperfect corundum; while the other variety, possessing these qualities, and comprising the oriental gems, is distinguished by the appellation of perfect corundum: these arrangements have received the sanction of chemical analysis. The skill of Klaproth, of Vauquelin, and Chenevix, has been exerted in investigating the composition of these fossils, and they have proved to be argil nearly pure. See DIAMOND, CORUNDUM, TELESIE, RUBY, SAPPHIRE, TOPAZ, AMETHYST, EMERALD, EMERY, BERYL, CHRYSOLYTE, CHRYSOBERYLL.

GENDARMES, or GENS D'ARMES, in the French armies, a denomination given to a select body of horse, on account of their succeeding the ancient gendarmes, who were thus called from their being completely clothed in armour.

GENDER, among grammarians, a division of nouns, or names, to distinguish the two sexes.

GENEALOGICA *arbor*, or tree of consanguinity, signifies a genealogy or lineage drawn out under the figure of a tree, with its root, stock, branches, &c. The genealogical degrees are usually represented in circles, ranged over, under, and aside each other.

GENEALOGY, an enumeration of a series of ancestors; or a summary account of the relations and alliances of a person or family, both in the direct and collateral line.

GENERAL *of an army*, in the art of war, he who commands in chief.

A general ought to be a man of great courage and conduct, to have great experience, and to be of good quality. His conduct appears in establishing his magazines in convenient places; in examining the country, that he may not engage his troops too far, while he is ignorant of the means of bringing them off; in subsisting them; and in knowing how to take the most advantageous posts, either for fighting or shunning a battle. His experience inspires his army with confidence, and an assurance of victory; and his quality, by creating respect, augments his authority. By his liberality he gets intelligence of the

Appendix concerning the Use of the Quadrant, Fore-staff, and Nocturnal," octavo; "Oratio in Laudem Gassendi Astronomiæ, habita in Aula Ædis Christi, Oxon;" and of several unpublished MSS. on the Doctrine of Eclipses, Lunar Astronomy, Ship Building, &c.

GEMINI, the Twins, in astronomy, one of the twelve signs of the zodiac, the third in order, beginning with aries. See ASTRONOMY.

GEMMA (REINIER), a learned Dutch physician and mathematician in the sixteenth century, was born at Dockum, in Friesland, in the year 1508. He was educated to the medical science, of which he became a professor in the university of Louvain. But he was particularly eminent for his proficiency in mathematics and astronomy, which he taught with distinguished reputation, and the character of being one of the best astronomers of his time. The fame of his great scientific knowledge, and of the excellent instruments which he made use of in the illustration of it, occasioned his being frequently invited to the court of the Emperor Charles V.; but he always modestly declined the overtures made to him, preferring the tranquillity of his literary retreat to the honours which he might expect from princely favour. He died at Louvain, in 1555, when only forty-seven years of age. He has sometimes had the surname of Friscius given him, from the country in which he was born. The most celebrated of his works were "Methodus Arithmeticæ;" "De usu Annuli Astronomici;" "De Locorum describendorum Ratione, deque Distantiis eorum inveniendis;" "Libellus de Principiis Astronomiæ et Cosmographia," &c. "Demonstrationes Geometricæ de usu Radii Astronomici," &c.; and "De Astrolabio Catholico Liber."

The author had a son, named Cornelius, who was born at Louvain, in 1535, and died in 1579. He was a poet, philosopher, and physician, and taught the mathematical sciences at Louvain with considerable reputation. He was the author of "De Arte Cyclognomicæ," &c.; "De Naturæ divinis Characterismis, seu Cosmocritico;" and "De Prodigiosa Specie Naturaque Cometæ," occasioned by the extraordinary new star in the constellation Cassiopeia, in 1572, which disappeared after being visible for eighteen months; and other pieces.

GEMMA, in botany, a bud, a compendium of a plant seated upon the stem and branches, and covered with scales, in order to defend the tender rudiments inclosed, from cold and other external injuries, till their parts being unfolded, they acquire strength, and render any further protection unnecessary. Buds, together with bulbs, which are a species of buds generally seated upon or near the root; constitute that part of the herb by Linnæus called hybernacula; that is, the winter quarters of the future vegetable, as it is during that severe season that the tender rudiments are protected in the manner just mentioned. Plants considered in analogy to animals, may properly enough be reckoned both viviparous and oviparous. Seeds are the vegetable eggs; buds, living fœtuses, or infant plants, which renew the species as certainly as the seed. In general, we may distinguish three kinds of buds: that containing the flower, that containing the leaves, and that containing both flower and leaves. The first, contains the rudiments of one or several flowers folded over one another, and surrounded with scales. In several trees, this kind of bud is commonly found at the extremity of certain small branches which are shorter, rougher, and less garnished with leaves than the rest. The external scales of this species of bud are harder than the internal; both are furnished with hairs, and in general more swelled than those of the second sort. The bud containing the flower, too, is commonly thicker, shorter, almost square, less uniform, and less pointed, being generally terminated obtusely. The second species of bud, contains the rudiments of several leaves which are variously folded over one another, and outwardly surrounded by scales, from which the small stipulæ that are seated at the foot of the young branches, are chiefly produced. These buds are commonly more pointed than the former sort. In the hazel-nut, however, they are perfectly round; and in horse-chesnut very thick. The third sort of bud is smaller than either of the preceding, and produces both flowers and leaves, though not always in the same manner. Sometimes the flowers and leaves are unfolded at the same time. This mode of the flower and leaf-bud admits of the following distinctions from the sex of the flowers so produced with the leaves: male flower and leaf-buds as in the pine and fir-tree; female flower and leaf-buds, as in hazel-nut and horn-beam; hermaphrodite flower and leaf-buds, as in the elm-tree, cornel-tree, mezereon, and almond tree.

GEMS, certain stones, which, on account

of their hardness, transparency, and beauty, when cut and polished, are highly esteemed, and from their small size and scarcity, are valued at very considerable price. The gems have been placed among the siliceous fossils, as in some measure allied with them in external characters; and silex was supposed to be their principal ingredient. Bergman first shewed the error of this opinion, and proved, by analysis, that in the emerald, sapphire, topaz, ruby, and hyacinth, argil predominates; their other constituent principles, as discovered by his analysis, being silex, lime, and oxide of iron. Still, however, the old prejudice prevailed, and they have been generally ranked by mineralogists under the siliceous genus.

The specific distinctions of these fossils were not less obscure; they were perplexed by the distinctions of the jewellers, drawn from very vague notions: the colour, in particular, being the property in which the gems differ most obviously, and which frequently gives them their mercantile value, served as a ground of distinction: hence the ruby, the sapphire, and the topaz were considered as different, though essentially the same. Another circumstance added to the confusion thus introduced, was that, other fossils, bearing a resemblance to these gems, had been classed with them; but, being inferior in lustre, transparency, and hardness, in order to distinguish between them, the epithet oriental was applied to those which were most perfect; and, by this contrivance, fossils were classed under one name, and regarded only as varieties of one species, which were totally different. The Oriental and the Saxon topaz, for example, were regarded under this point of view, or as varieties of one species, to which the common name of topaz belonged, though they are fossils altogether distinct. From these two circumstances, fossils were separated which ought to have been associated, and others were connected, which were specifically different; and it has required much mineralogical discussion to disentangle the perplexity, and establish the proper species.

Romi de l'Isle threw the first ray of light on this subject, by disregarding the colour, and attending rather to the form of crystallization; in consequence of which he arranged together the principal gems named oriental, under the title of the oriental ruby. Werner also has placed them under one species, to which he gives the name of sapphire. Hauy has adopted the same arrangement, distinguishing the species by the name of télésie; and, more lately, Bournon has still farther extended the relations of these fossils, by connecting them with the corundum, a fossil which had been brought from India, and which, analysed by Klaproth, was found to be composed principally of argillaceous earth. This, having in general little transparency or lustre, Bournon names imperfect corundum; while the other variety, possessing these qualities, and comprising the oriental gems, is distinguished by the appellation of perfect corundum: these arrangements have received the sanction of chemical analysis. The skill of Klaproth, of Vauquelin, and Chenevix, has been exerted in investigating the composition of these fossils, and they have proved to be argil nearly pure. See Diamond, Corundum, Telesie, Ruby, Sapphire, Topaz, Amethyst, Emerald, Emery, Beryl, Chrysolyte, Chrysoberyll.

GENDARMES, or Gens d'armes, in the French armies, a denomination given to a select body of horse, on account of their succeeding the ancient gendarmes, who were thus called from their being completely clothed in armour.

GENDER, among grammarians, a division of nouns, or names, to distinguish the two sexes.

GENEALOGICA *arbor*, or tree of consanguinity, signifies a genealogy or lineage drawn out under the figure of a tree, with its root, stock, branches, &c. The genealogical degrees are usually represented in circles, ranged over, under, and aside each other.

GENEALOGY, an enumeration of a series of ancestors; or a summary account of the relations and alliances of a person or family, both in the direct and collateral line.

GENERAL *of an army*, in the art of war, he who commands in chief.

A general ought to be a man of great courage and conduct, to have great experience, and to be of good quality. His conduct appears in establishing his magazines in convenient places; in examining the country, that he may not engage his troops too far, while he is ignorant of the means of bringing them off; in subsisting them; and in knowing how to take the most advantageous posts, either for fighting or shunning a battle. His experience inspires his army with confidence, and an assurance of victory; and his quality, by creating respect, augments his authority. By his liberality he gets intelligence of the

strength and designs of the enemy, and by this means is enabled to take the most successful measures. A general ought likewise to be fond of glory, to have an aversion to flattery, to render himself beloved, and to keep a strict discipline.

The office of a general is to regulate the march and encampment of the army; in the day of battle to choose out the most advantageous ground; to make the disposition of the army; to post the artillery; and where there is occasion, to send his orders by his aids-de-camp. At a siege, he is to cause the place to be invested; to order the approaches and attacks; to visit the works, and to send out detachments to secure his convoys.

General *issue*, in law, is that plea which traverses and denies at once, the whole declaration or indictment, without offering any special matter, whereby to evade it: and it is called the general issue, because, by importing an absolute and general denial of what is alleged in the declaration, it amounts at once to an issue; that is, a fact affirmed on one side, and denied on the other. This is the ordinary plea upon which most causes are tried, and is now almost invariably used in all criminal cases. It puts every thing in issue, that is, denies every thing, and requires the party to prove all that he has stated.

It is a frequent question what can be given in evidence by the defendant upon this plea, and the difficulty is to know when the matter of defence may be urged upon the general issue, or must be specially pleaded upon the record. In many cases, for the protection of justices, constables, excise officers, &c. they are by act of parliament enabled to plead the general issue, and give the special matter for their justification under the act in evidence.

GENERATING *line*, or *figure*, in geometry, is that by which its motion produces any other plane or solid figure. Thus, a right line moved any way parallel to itself, generates a parallelogram; round a point in the same plane, with one end fastened in that point, it generates a circle. One entire revolution of a circle, in the same plane, generates the cycloid; and the revolution of a semi-circle round its diameter, generates a sphere, &c. See Cycloid, Sphere, &c.

GENERATION. See Physiology.

GENERICAL *name*, in natural history, the word used to signify all species of natural bodies, which agree in certain essential and peculiar characters, and therefore all of the same family or kind; so that the word used as the generical name, equally expresses every one of them, and some other words expressive of the peculiar qualities of figures of each are added, in order to denote them singly, and make up what is called the specific name. Thus the word rosa, or rose, is the generical name of the whole series of flowers of that kind, which are distinguished by the specific names of the red-rose, the white-rose, the apple-rose, &c.

GENEVA, *gin*, a hot fiery spirit, too much used by the lower classes of people in this country, as a dram, and is unquestionably most injurious to their constitution and morals. A liquid of this kind was formerly sold in the apothecaries shops, drawn from the juniper-berry, but distillers now have completely supplanted the trade of the apothecary, who sell it under the name of geneva, or gin, in which, it is believed, juniper-berries make no part of the composition. It is composed of oil of turpentine, and malt spirits. A better sort is said to be drawn off by a slow fire, from juniper-berries, proof-spirits, and water, in the proportion of three pound of berries to four gallons of water and ten of spirit. The celebrated Hollands geneva is manufactured chiefly at a village near Rotterdam, from the same materials, making use of French brandy instead of malt-spirits.

GENIOSTOMA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx turbinate, five-cleft; corolla one-petalled, with a villose throat, and a five-parted border; capsule oblong, two-celled, many-seeded. There is but one species, a native of the isle of Tanna, in the South Seas.

GENISTA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx two-lipped, two and three-toothed; banner oblong, reflex downwards from the pistil and stamens. There are seventeen species.

GENIUS, in matters of literature, &c. a natural talent or disposition to do one thing more than another; or the aptitude a man has received from nature to perform well and easily that which others can do but indifferently, and with a great deal of pains.

GENTIAN, in pharmacy, is to be found in many countries, but particularly in some parts of France, on the Alps, Pyrenees, and the mountainous districts of Germany.

That used in this country is mostly brought from Germany. The roots are the only part of the plant made use of in medicine. Gentian stands at the head of the stomachic bitters.

GENTIANA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Rotaceæ. Gentianæ, Jussieu. Essential character: corolla monopetalous; capsule superior, two-valved, one-celled, with two longitudinal receptacles. There are fifty-three species.

GENUS, among metaphysicians and logicians, denotes a number of beings, which agree in certain general properties, common to them all; so that a genus is an abstract idea, expressed by some general name or term.

A genus is an assemblage of several species; that is, of several plants which resemble one another in their most essential parts. Hence it is aptly enough compared to a family, all the relations of which bear the same surname, although every individual is distinguished by a particular specific name. In botany the establishment of genera renders the subject more simple and easy, by abridging the number of names, and arranging under one denomination, termed the generic name, several plants, which, though different in many other respects, are found invariably to possess certain relations in those essential parts, the flower and fruit. Plants of this kind are termed by botanists plantæ congeneres, that is, plants of the same genus.

Linnæus's genera, contain a description of each particular part of fructification, its various relations, and different modes with respect to number, figure, situation, and proportion. Thus, all the different species of calyx, corolla, nectarium, stamina, &c. furnish the observer with so many sensible and essential characters. These characters the author denominates the letters or alphabet of botany. By studying, comparing, and, as it were, spelling these letters, the student in botany comes, at length, to read and understand the generical characters which the great Creator has originally imprinted upon vegetables: for the genera and species, according to Linnæus, are solely the work of nature; whilst the classes and orders are a combination of nature and art. Upon these principles, Linnæus, in his genera plantarum, determines the generical characters of all the plants there described.

GENUS, in natural history, a sub-division of any class or order of natural beings, whether of the animal, vegetable, or mineral kingdoms, all agreeing in certain common characters.

GEOCENTRIC *latitude of a planet*, is its distance from the ecliptic as it is seen from the earth, which, even though the planet be in the same point of her orbit, is not constantly the same, but alters according to the position of the earth in respect to the planet.

GEOCENTRIC *place of a planet*, the place wherein it appears to us from the earth, supposing the eye there fixed: or it is a point in the ecliptic to which a planet seen from the earth is referred.

GEODÆSIA, the same with surveying. See SURVEYING.

GEOFFROYA, in botany, so named in honour of Monsieur Geoffroy, a member of the academy at Paris, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx five-cleft; drupe ovate; nut flatted. There are two species.

GEOGRAPHY, is that science which exhibits the results of our investigations respecting the planet we inhabit, whether we consider its figure and the disposition of the lands and water upon its surface, or the subdivisions which the different nations who inhabit it have made, by which it is considered as forming kingdoms and states.

The general curvature of the earth's surface is easily observable in the disappearance of distant objects; and, in particular, when the view is limited by the sea, the surface of which, from the common property of a fluid, becomes naturally smooth and horizontal; for it is well known that the sails and rigging of a ship come into view long before her hull, and that each part is the sooner seen as the eye is more elevated.

On shore, the frequent inequalities of the solid parts of the earth usually cause the prospect to be bounded by some irregular prominence, as a hill, a tree, or a building, so that the general curvature is the less observable.

The surface of a lake, or sea, must be always perpendicular to the direction of a plumb line, which may be considered as the direction of the force of gravity; and by means either of a plumb line, or of a spirit level, we may ascertain the angular situation of any part of the earth's surface with respect to a fixed star passing the meridian; by going a little further north or south, and repeating the observation on the star, we

may find the difference of the inclination of the surfaces at both points; of course, supposing the earth a sphere, this difference in latitude will be the angle, subtended at its centre by the given portion of the surface, whence the whole circumference may be determined; and on these principles the earliest measurements of the earth were conducted. The first of these, which can be considered as accurate, was executed by Picart, in France, towards the end of the seventeenth century.

But the spherical form is only an approximation to the truth. It was calculated by Newton, and ascertained experimentally by the French academicians, sent to the equator and to the polar circle; that, in order to represent the earth, the sphere must be flattened at the poles, and prominent at the equator. We may therefore consider the earth as an oblate elliptic spheriod; the curvature being greater and consequently every degree shorter at the equator, than nearer the poles. If the density of the earth were uniform throughout, its ellipticity, or the difference of the length of its diameters would be $\frac{1}{230}$ of the whole; on the other hand, if it consisted of matter of inconsiderable density, attracted by an infinite force in the centre, the ellipticity would be only $\frac{1}{577}$; and whatever may be the internal structure of the earth, its form must be between these limits, since its internal parts must necessarily be denser than those parts which are nearer the surface. If, indeed, the earth consisted of water or ice, equally compressible with common water or ice, and following the same laws of compression with elastic fluids, its density would be several thousand times greater at the centre than at the surface; and even steel would be compressed into one-fourth of its bulk, and stone into one-eighth, if it were continued to the earth's centre; so that there can be no doubt but that the central parts of the earth must be much more dense than the superficial.

Whatever this difference may be, it has been demonstrated by Clairaut, that the fractions expressing the ellipticity and the apparent diminution of gravity at the equator, must always make together $\frac{5}{576}$; and it has been found, by the most accurate observations on the lengths of pendulums in different latitudes, that the force of gravity is less powerful by $\frac{1}{180}$ at the equator than at the pole, whence the ellipticity is found to be $\frac{1}{320}$ of the equatorial diameter; the form being the same as would be produced, if about three-eighths of the whole force of gravity were directed towards a central particle, the density of the rest of the earth being uniform.

This method of determining the general form of the earth is much less liable to error and irregularity, than the measurement of the lengths of degrees in various parts, since the accidental variations of curvature produced by local differences of density, and even by superficial elevations, may often produce considerable errors in the inferences which might be deduced from these measurements. For example, a degree measured at the Cape of Good Hope, in latitude 33° south, was found to be longer than a degree in France, in latitude 46° north, and the measurements in Austria, in North America, and in England, have all exhibited signs of similar irregularities. There appears also to be some difference in the length of degrees under the same latitude, and in different longitudes. We may, however, imagine a regular elliptic spheroid to coincide very nearly with any small portion of the earth's surface, although its form must be somewhat different for different parts: thus, for the greater part of Europe, that is, for England, France, Italy, and Austria, if the measurements have been correct, this oscillating spheroid must have an ellipticity of $\frac{1}{150}$.

The earth is astronomically divided into zones, and into climates. The torrid zone is limited by the tropics, at the distance of 23° 28′ on each side of the equator, containing all such places as have the sun sometimes vertical, or immediately over them: the frigid zones are within the polar circles, at the same distance from the poles, including all places which remain annually within the limit of light and darkness, for a whole diurnal rotation of the earth, or longer; the temperate zones, between these, have an uninterrupted alternation of day and night, but are never subjected to the sun's vertical rays. At the equator, therefore, the sun is vertical at the equinoxes, his least meridian altitude is at the solstices, when it is 66° 32′, that is, more than with us at Midsummer; and this happens once on the north, and once on the south side of the hemisphere. Between the equator and the tropics he is vertical twice in the year, when his declination is equal to the latitude of the place, and his least meridian altitudes, which are unequal between themselves, are at the solstices.

At the tropics, the meridian sun is vertical once only in the year, and at the opposite solstice, or the time of midwinter, his meridian altitude is 43° 4′, as with us in April and the beginning of September. At the polar circles the sun describes, on midsummer-day, a complete circle, touching the north or south point of the horizon; and in midwinter he shows only half his disc above it, for a few minutes, in the opposite point; that is, neglecting the elevation produced by refraction, which, in these climates, especially, is by no means inconsiderable. At either pole, the corresponding pole of the heavens being vertical, the sun must annually describe a spiral, of which each coil is nearly horizontal, half of the spiral being above the horizon, and half below; the coils being much more open in the middle than near the end.

The climates, in the astronomical sense of the word, are determined by the duration of the longest day in different parts of the earth's surface; but this division is of no practical utility, nor does it furnish any criterion for judging of the climate in a meteorological sense.

The natural division of the surface of the globe is into sea and land; about three-fourths of the whole being occupied by water, although probably no where to a depth comparatively very considerable, at most of a few miles on an average. The remaining fourth consists of lands, elevated more or less above the level of the sea, interspersed, in some parts, with smaller collections of water, at various heights, and in a few instances, somewhat lower than the general surface of the main ocean. Thus the Caspian Sea is said to be about three hundred feet lower than the ocean; and in the interior parts of Africa there is probably a lake equally depressed.

We cannot observe any general symmetry in this distribution of the earth's surface; excepting that the two large Continents of Africa and South America, have some slight resemblance in their forms, and that each of them is terminated to the eastward by a collection of numerous islands. The large capes projecting to the southward have also a similarity with respect to their form, and the islands near them; to the west the continents are excavated into large bays, and the islands are to the east: thus Cape Horn has the Falkland Islands; the Cape of Good Hope, Madagascar; and Cape Comorin, Ceylon to the east.

The great continent, composed of Europe, Asia, and Africa, constitutes about a seventh of the whole surface of the earth; America about a sixteenth; and Australasia, or New South Wales, about a fiftieth; or in hundredth parts of the whole, Europe contains two; Asia, seven; Africa, six; America, six; and Australasia, two; the remaining seventy-seven being sea; although some authors assign seventy-two parts only out of one hundred to the sea, and twenty-eight to the land.

These proportions may be ascertained with tolerable accuracy, by weighing the paper made for covering a globe, first entire, and then cut out according to the terminations of the different countries; or, if still greater precision were required, the greater part of the continents might be divided into known portions of the whole spherical surface, and the remaining irregular portions only weighed.

The general inclinations and levels of the continents are discovered by the course of their rivers. Of these the principal are, the river of Amazons, the Senegal, the Nile, the river St. Lawrence, the Hoangho, the river La Plata, the Jenisei, the Mississippi, the Volga, the Oby, the Amur, the Oronooko, the Ganges, the Euphrates, the Danube, the Don, the Indus, the Dnieper, and the Dwina; and this is said to be nearly the order of their magnitudes. But if we class them according to the length of country through which they run, the order will, according to Major Rennel's calculation, be somewhat different; taking the length of the Thames for unity, he estimates that of the river of Amazons, at $15\frac{3}{4}$; the Kian Kew, in China, $15\frac{1}{2}$; the Hoango, $13\frac{1}{2}$; the Nile, $12\frac{1}{2}$; the Lena, $11\frac{1}{2}$; the Amur, 11; the Oby, $10\frac{1}{2}$; the Jenisei, 10; the Ganges, its companion the Burrampooter, the river of Ava, and the Volga, each $9\frac{1}{2}$; the Euphrates, $8\frac{1}{2}$; the Mississippi, 8; the Danube, 7; the Indus, $5\frac{1}{2}$; and the Rhine, $5\frac{1}{4}$.

We may form a tolerable accurate idea of the levels of the ancient continent, by tracing a line across it in such a direction as to pass no river, which will obviously indicate a tract of country higher than most of the neighbouring parts. Beginning at Cape Finisterre, we soon arrive at the Pyrenees, keeping to the south of the Garronne, and the Loire.

After taking a long turn northwards, to avoid the Rhine, we come to Swisserland, and we may approach very near to the Mediterranean in the state of Genoa, taking care not to cross the branches of the Po. We

make a circuit in Swisserland, and pass between the sources of the Danube, and of the branches of the Rhine, in Swabia. Crossing Franconia, we leave Bohemia to the north, in order to avoid the Elbe; and coming near to the borders of Austria, follow those of Hungary to the south of the Vistula. The Dnieper then obliges us to go northwards through Lithuania, leaving the Don wholly to the right; and the Volga, to pass still further north, between Petersburg and Moscow, a little above Bjelosero. We may then go eastwards to the boundary of Asia, and thence northwards to Nova Zembla. Hence we descend to the west of the Oby, and then to the east of the branches of the Volga, and the other inland rivers flowing into the lake Aral and the Caspian Sea. Here we are situated on the widely extended elevation of India, in the neighbourhood of the sources of the Indus; and, lastly, in our way from hence towards Kamschatka, we leave the Jenisei and Lena on the left, and the Ganges, the Kiang Kew, the Hoangho, and the Amur to the right.

The direction of the most conspicuous mountains is, however, a little different from this; the principal chain first constitutes the Pyrenees, and divides Spain from France, then passes through Vivarais and Auvergne, to join the Alps, and through the south of Germany to Dalmatia, Albania, and Macedonia; it is found again beyond the Euxine, under the names of Taurus, Caucasus, and Imaus, and goes on to Tartary and to Kamschatka. The peninsula of India is divided from north to south by the mountains of Gate, extending from the extremity of Caucasus to Cape Comorin. In Africa, Mount Atlas stretches from Fez to Egypt, and the mountains of the Moon run nearly in the same direction: there is also a considerable elevation between the Nile and the Red Sea. In the new world, the neighbourhood of the western coast is in general the most elevated; in North America the Blue Mountains, or Stony Mountains, are the most considerable; and the mountains of Mexico join the Andes or Cordeliers, which are continued along the whole of the west coast of South America.

There are several points in both hemispheres, from which we may observe rivers separating to run to different seas; such are Swisserland, Bjelosero, Tartary, Little Tibet, Nigritia or Guinea, and Quito. The highest mountains, are Chimboraçao, and some others of the Cordeliers in Peru, or perhaps Descabesado in Chili, Mont Blanc, and the Peak of Teneriffe. Chimboraçao is about seven thousand yards, or nearly four miles, above the level of the sea; Mont Blanc, five thousand, or nearly three miles; the Peak of Teneriffe about four thousand, or two miles and a quarter; Ophir, in Sumatra, is said to be five or six hundred feet higher. It has, however, been asserted, that some of the snowy mountains to the north of Bengal, are higher than any of those of South America. The plains of Quito, in Peru, are so much elevated, that the barometer stands at the height of fifteen inches only, and the air is reduced to half its usual density. But none of these heights is equal to a thousandth part of the earth's semi-diameter, and the greatest of them might be represented on a six inch globe by a single additional thickness of the paper with which it is covered. Mount Sinai, in Japan, Mount Caucasus, Etna, the Southern Pyrenees, St. George among the Azores, Mount Adam, in Ceylon, Atlas, Olympus, and Taurus, are also high mountains; and there are some very considerable elevations in the island of Owyhee. Ben Nevis, in Scotland, is the loftiest of the British hills, but its height is considerably less than a mile.

The most elevated mountains, excepting the summit of volcanos, consist of rocks, more or less mixed, without regular order, and commonly of granite or porphyry. These are called primary mountains; they run generally from east to west in the old world, and from north to south in the new; and many of them are observed to be of easier ascent on the east than the west side. The secondary mountains accompany them in the same direction; they consist of strata, mostly calcarious and argillaceous, that is, of the nature of lime-stone and clay, with a few animal and vegetable remains, in an obscure form, together with salt, coals, and sulphur. The tertiary mountains are still smaller; and in these, animal and vegetable remains are very abundant; they consist chiefly of lime-stone, marble, alabaster, building-stone, mill-stone, and chalk, with beds of flint. Where the secondary and tertiary mountains are intersected by vallies, the opposite strata often correspond at equal heights, as if the vallies had been cut or washed from between them; but sometimes the mountains have their strata disposed as if they had been elevated by an internal force, and their summits had afterwards crumbled away,

the strata which are lowest in the plains being highest in the mountains. The strata of these mountains are often intermixed with veins of metal, running in all possible directions, and occupying vacuities which appear to be of somewhat later date than the original formation of the mountains. The volcanic mountains interrupt those of every other description, without any regularity, as if their origin were totally independent of all the rest.

The internal constitution of the earth is little known from actual observation, for the depths to which we have penetrated are comparatively very inconsiderable, the deepest mine scarcely descending half a mile perpendicularly. It appears that the strata are more commonly in a direction nearly horizontal than in any other; and their thickness is usually almost equable for some little distance; but they are not disposed in the order of their specific gravity, and the opinion of their following each other in a similar series, throughout the greater part of the globe, appears to rest on very slight foundations.

From observations on the attraction of the mountain Schehallien, Dr. Maskelyne inferred the actual mean density of the earth to be to that of water as four and a half to one, judging from the probable density of the internal substance of the mountain, which he supposed to be a solid rock. Mr. Cavendish has concluded more directly, from experiments on a mass of lead, that the mean density of the earth is to that of water as five and a half to one. Mr. Cavendish's experiments, which were performed with the apparatus invented and procured by the late Mr. Michell, appear to have been conducted with all possible accuracy, and must undoubtedly be preferred to conclusions drawn from the attraction of a mountain, of which the internal parts are perfectly unknown to us, except by conjectures founded on its external appearance. Supposing both series of experiments and calculations free from error, it will only follow that the internal parts of Schehallien are denser, and perhaps more metallic, than was before imagined. The density assigned by Mr. Cavendish is not at all greater than might be conjectured from observations on the vibration of pendulums; Newton had long ago advanced it as a probable supposition, that the mean density of the earth might be about five or six times as great as that of water, and the perfect agreement of the result of many modern experiments with this conjecture affords us a new proof, in addition to many others, of the accuracy and penetration of that illustrious philosopher. See GLOBES.

GEOLOGY has for its object the structure and formation of this globe: it, of course, embraces the consideration of the materials of which it is composed, and the circumstances peculiar to its original formation, as well as the different states under which it has existed, and the various changes which it has undergone.

It necessarily follows, from the very limited depth within which our actual examinations have been made, that our facts and real observations are confined to what may be considered, comparatively, as merely the crust of the globe. With respect to its more internal part, we have hitherto only been aided by conjecture, which, it must be admitted, has too frequently led to theories the most extravagant and absurd. From the experiments of several learned men, it, however, appears, that the density of the globe is greatest towards its centre. Boscovich is of opinion, from his very ingenious calculations, that the centre is a spherical nucleus, possessing an equal degree of density to within some leagues of the earth's surface; but although it is thus concluded, that the interior of the earth is solid, contrary to the conjectures of several ancient philosophers, yet it is by no means pretended, that even in this its more solid parts, there may not exist cavities of a greater or less size, connected, perhaps, with each other, and extending considerably, in all probability, towards the surface.

The solid masses of the globe, which have come within our examination, have been distinguished into primitive and secondary; among the former, were placed the rocks of granite, gneiss, porphyry, serpentine, and limestone, of a peculiar character; and, among the latter, were considered the rocks of secondary lime-stone, of phosphate of lime, of gypsum, and of some of the sandstones; of chalk, and of silex. This division is not, however, at present universally adopted; other divisions having been assumed, which have appeared to agree better with the different systems which have been proposed: these divisions we shall therefore more fully notice, after pointing out the peculiarities of these several systems. The water is supposed, at present, to cover about three-fifths of the whole earth; but

undoubted evidence exists, of its having extended over a much wider surface; and it is the opinion of many of the most eminent geologists, of its having covered the whole of the earth. As the necessity of ascertaining this latter circumstance is much urged, by those who have endeavoured to form correct opinions respecting the mode in which this globe was originally formed, it will be proper here to notice some of the evidence which has been adduced respecting this circumstance.

Herodotus relates, that, according to the priests of Vulcan, the whole of Egypt, except in the neighbourhood of Thebes, had been covered with water. Herodotus himself, also, noticed the existence, even in his time, of lakes of salt water in different parts of Egypt, as well as of the saline matter, mingled with the vast tracts of sand with which that country is covered; which observations are confirmed by the accounts that have been given, by those who have examined these parts in modern times. The diminution of the ocean is also rendered in the highest degree probable, from various facts related also by Strabo, Pliny, Diodorus the Sicilian, and several other early writers; and in the present day, the observations of Pallas, Celsius, Linnæus, and others, seem to establish the fact, of the diminution and sinking both of the Baltic and of the Caspian Seas.

On the other hand, innumerable facts may be adduced which seem to prove, that the water has actually increased, in its proportion, over the dry land. From the relations of Plaucus, Bryden, Barral, Fortis, and others, there can no doubt exist of the Mediterranean Sea having very much encroached on its shores; temples, and other edifices of different descriptions, which are known to have been erected at considerable distances from the sea, being now buried beneath its waves. In explanation of this varying evidence, it is necessary to state, although it may not affect the general question, that it cannot be doubted, that whilst the land is gaining on the sea, in some parts, similar encroachments are observable in others, of the sea on the dry land. Instances of this, on the small scale, may be observed on almost all flat, and on many precipitous shores; on the former, large embankments of sand are sometimes suddenly thrown up by considerable and violent inundations, and which, in consequence of alteration in the shape of the coasts, and of the direction of currents, may still remain, and appear to manifest an increase of the dry land: on precipitous shores, the reverse of this is observable; undermined by the continual and powerful action of the waves, large masses are perpetually falling, and, broken by their fall and by the action of the water, are so reduced as to easily allow of their removal by the waves: thus is occasioned a considerable reduction of the level of the shore; and thus an opportunity is given for the extension of the waters of the ocean on such particular spots. The balance, however, of this seemingly contradictory evidence, is undoubtedly in favour of the opinion, that the water has considerably diminished, and is, perhaps, lessening at the present period.

Indubitable evidence of the water having stood over the tops of mountains, which are at present much above the level of the ocean, is yielded, by the circumstance of various organized beings, former inhabitants of the water, being imbedded in these mountains, and even in their summits. Those who contend that the whole of the earth has been covered with water, have recourse to the testimony afforded by the several chemical and physical properties, discoverable in the component parts of the loftiest mountains; and which prove, in their opinion, that all these substances have obtained their origin from the waters of the ocean, which they suppose to have invested the whole earth. This mode of the formation of rocks will not, however, be admitted by every geologist, to be sufficiently ascertained, to allow of its being adduced as an evidence on the present occasion. That they have been thus produced, there appears, however, to be the greatest reason for supposing; but as their origin still remains a question with many, the testimony, on this occasion, must be proportionally weakened.

In the following sketch of some of the most interesting and important systems of the formation of the world, several facts will be noticed, from which additional evidence will be adduced, of not only the formation of the rocks from the contents of the primitive waters, but also of the waters having totally covered the earth; and since most of the important geological facts will come into consideration, whilst taking a view of the different systems which have been offered of the formation of the world, and of the several changes which it has undergone, it is proposed to appropriate the

remaining part of this article to that purpose.

Omitting to notice any further the scriptural account of the creation of the world, merely on account of the brevity of the narration preventing the disposal of the events, there related, in a systematic arrangement; we shall only here generally remark, that the occurrence of the most prominent circumstances related in that account, has been repeatedly inferred by the most learned writers, who have endeavoured, from a view of the present state of the world, and of the various changes which it has undergone, to form some conjectures with respect to its original formation.

From the very imperfect accounts which have reached us, of the doctrines of the Egyptian philosophers on this subject, we can only learn, that they were of opinion, that at the beginning the water had covered the whole surface of the world; and that this was proved by the remains of organized beings, which were so frequently seen in the substance of the earth. These waters, it was supposed, had retired to the interior cavities of the globe, remaining in this great abyss, ready to issue out and produce the most extensive inundations; to one of which it was supposed that some of their records referred. The axis of the globe, they believed to have been originally parallel with that of the plane of its orbit; and whilst it remained thus, they supposed that a perpetual spring existed; but that, on its inclining, an alteration of seasons took place.

The Chaldæans, like the Egyptians, are supposed, by Diodorus Siculus, to have believed the earth to be hollow; and that, in the early ages of its formation, a perpetual spring had existed. The Indians also believed in the existence of a vast abyss in the centre of the earth, for the reception of the water, which remained after the consolidation of the crust of the earth: they also believed in a general deluge of the earth, and in a subsequent retiring of the waters.

The opinions of the Epicureans, as delivered to us by Lucretius, appear to have been, that by the separation and appropriate re-union of accordant atoms, the different elements were formed, which, by the regulating influence of gravity, were separated from each other, and disposed in their allotted regions. One of the processes which was thus performed, was the formation of the earth itself; which, being then variously acted upon, underwent those alterations of its surface, from which proceeded the vast cavities for the reception of the ocean, and those irregularities which divide its surface into hills and vallies.

Since several of the hypotheses of the formation of the world, and the changes which have brought it to its present state, deserve rather to be regarded as ingeniously devised allegories, than systems regularly deduced, it is not intended to do much more than specify those, the consideration of which will yield but little information. In agreement with this rule, we shall only state, respecting the hypothesis of Des Cartes, that he conceived, that this globe might originally have been composed, like the sun, of the pure element (fire); but that, by degrees, its less subtle parts had gradually collected together, and formed thick and obscure masses at its surface, similar to those accumulations which occasion the spots which we see on the sun. From the gradual, but, at length, complete incrustation thus formed, he supposed, that the whole planet, at length, became covered and obfuscated; that, in this manner, different crusts were formed, and that, from the falling in of parts of the exterior crust into the cavity beneath, the irregularities of the earth's surface were produced.

To this hypothesis of Des Cartes, that of Leibnitz very nearly approaches, he supposed the crust, of which we have just spoken, to have been of a vitreous nature, the minute fragments of which are the sand that is every where so abundant. The affinity of our earth to the sun, has been more strictly asserted by Buffon, who informs us, that the earth was originally separated from the sun, by the stroke which the sun received from the falling in of a comet, that this fragment, during its cooling, acquired, from its rotation, a spheroidal form, cavities being, at the same time, formed in its interior part, whilst its vapours condensed, and formed the waters of the ocean. Bicher entertained the opinion, that there existed in the centre of the globe a cavity, which contained an accumulation of sulphurous, bituminous, and other mineral principles, which, raised in the state of vapours, by the internal heat, formed the various mineral substances which are contained in the substance of the earth. This hypothesis, so little supported by probability, has been nearly adopted in modern times, by Gensanne, in his "History of Languedoc;" who imagines the existence of a central fire, by the influence of which nume-

rous mineral principles are raised, in a state of vapour, through the different clefts of the earth, until they arrive near to its surface, where they enter into various combinations; the result of this is the production of the numerous mineral substances which the earth contains.

Besides these, who consider an inherent or central fire as necessary to the formation and continuation of this globe, there are others who refer the particular modification of the form of its surface to the operation of subterraneous fires, acting partially by the incalescence of pyrites and volcanic eruptions, with accompanying earthquakes; amongst those who have adopted this opinion, may be mentioned Steno, Lazare, Moro, and Ray.

To produce the vast effects necessary to give form to a planet, or to modify its surface anew, must of course require the most powerful physical agents. In the various systems, therefore, which human ingenuity has devised, with the hope of pointing out the natural means which have been employed in these prodigious operations, the powerful agency of fire or of water has been generally referred to; and hence geologists have been rather whimsically named, according to the particular agency which they have supported in their discussions, Plutonists, and Neptunists. The systems already here noticed, it is obvious, are those in which fire has been adopted, as almost the sole agent; in those which next will engage our attention, recourse has been had to the combined powers of both agents.

Dr. Burnet, whose system manifests a considerable portion both of ingenuity and judgment, supposes the earth to have originally been a fluid mass, the component parts of which became arranged according to their gravity; hence the heaviest matters were deposited at the centre, and above these were disposed, in concentric layers, the substances which were less and less heavy, and on the surface was the earth, covered all round by the water, which was itself invested by an unctuous matter, around which existed the circumambient air. By the subsequent intermixture of the oily matter and earth, and other arrangements of its several component parts, the crust of earth acquired a smooth form, and obtained those qualities which were necessary for the existence of organized beings. At this period, the axis of the globe was supposed to be parallel with that of its orbit, the days and the nights to be equal in length, and a uniform season to have existed, resembling a perpetual spring; but on the crust of the earth drying, from the ardency of the heat, it became violently rent asunder, falling into, and giving openings for the vast abyss of waters beneath: hence the axis of the globe became inclined, occasioning those changes of the seasons, and of the length of the days and nights, which now exist; and thus also were produced the beds of the ocean, with the vallies and the numerous mountainous elevations.

Mr. Whiston conjectured, that the earth was originally a comet, which, at the period mentioned in the Mosaic account, as that of the creation of the world, had its orbit rendered nearly circular, and such an arrangement formed of its component parts, as made it fit for the existence of the vegetable and animal creation: having existed in this state its allotted time, he supposes a comet to have passed so near to the earth as to have involved it in the vapours forming its tail, and which, being condensed, fell in torrents, and produced the deluge described by Moses; the action of the comet on the earth itself, having been sufficient to produce, at the same time, those irregularities of its surface, which form chains of mountains and the vast beds of the ocean.

Mr. Pallas having assumed the formation of the sea and the primitive rocks, supposed that, with the sand produced by their constant disintegration, the sea must have deposited such inflammable and ferruginous matters, as, being disposed in beds on the granite, would form the fuel of volcanoes; these, raising and bursting the solid beds under which they had existed, and which they must have altered by fusion or calcination, would raise up the mountains of schist and of lime-stone. The shores of the sea being gradually augmented, the sea being diminished and driven back, whilst its bed was raised in different parts by the power of volcanoes, the formation of the mountains containing petrifactions would take place. Lastly, he supposed, after the earth had been well stocked with vegetables and animals, that by some enormous eruptions at the bottom of the sea, its waters may have been made to inundate the whole horizontal surface of the earth, and even those mountains which have not exceeded one hundred toises in height.

The system of Dr. Hutton resembles, in many points, that which has been just noticed; but its several parts are better con-

nected, and it certainly possesses, although in its tendency it is highly exceptionable, a more prepossessing appearance, since it ascribes the formation of continents, of mountains, vallies, &c. not to accidental occurrences, but to the operation of regular and uniform causes; making the decay of one part subservient to the restoration of another, by successive reproductions. Thus he supposes this globe to be regulated by a system of decay and renovation, and that these are effected by certain processes which bear a uniform relation to each other. The solid matter of the earth, especially of the rocks and high lands, he supposes to be perpetually separating by the reiterated action of air and water, and when thus detached, carried by the streams and rivers, and then deposited in the beds of the ocean. From these deposits, the various strata of our earth are supposed to be formed, obtaining their consolidation from the action of sub-marine fires; which being placed at immense depths, must operate on these stratified depositions under the circumstance of vast pressure; by which volatilization must be prevented, and such changes produced as would not otherwise be effected by the power of heat. The expansive power of subterraneous fire, is called also in to explain, by the elevation of strata, their various positions. Thus, whilst the ocean is in one part removed by the accumulation, and the elevation of strata, fresh receptacles are forming for it on other spots, where new strata will be deposited, rendered solid, and elevated.

According to this system, therefore, in the present world, which is made up of the fragments of those which preceded it, the materials are arranging for the formation of its successor; the system manifesting, as its author avowed, neither vestige of a beginning nor prospect of an end.

Having thus sketched the outlines of the most interesting of the systems, which suppose the formation of this globe to have chiefly depended on the agency of fire, we shall now proceed to take a view of those in which the same effect is described, as having been produced by the influence of water.

Woodward, with too little attention to facts, well known at the period at which he wrote, supposed that the solid parts of the earth were arranged in strata, according to their degrees of specific gravity; the water which had held them in solution, having afterwards retreated to the grand abyss which he supposed to exist in the centre. After some time, God ordained that the crust should break and fall into the abyss, and that the water should cover the surface. By the great solvent powers of this water, he supposed that every thing was again dissolved, and that afterwards they were again precipitated in concentric layers. The surface was then supposed to have been again broken, by which the waters again reached the centre, and the broken surface yielded those inequalities which now exist.

De Luc conceived, that in the beginning the sun did not exist in a luminous state, and that the earth, not feeling its influence, was frozen; but that, as the sun diffused its rays, the ice on the earth's surface became thawed, and penetrating inwards, dissolved the earth and other frozen matters to the depth of several leagues below the surface. But the thaw having reached this point, he supposes that the dissolved substances became either crystallized or precipitated, and that as they solidified they formed the primitive crust of the earth. After this, organized beings were created, many of which became involved in new strata, (the secondary) which were now formed at the bottom of the ocean; and the thawing of the internal parts of the globe continuing, cavities were formed, in consequence of the thawed substances possessing less space than they did whilst frozen. The whole of the crust, thus losing its support, sunk partially, at different periods, and the external water rushed in to fill the cavities which existed, and thus caused a considerable diminution of the waters which covered the earth; whilst, from the overturned fragments, arose the irregularities of the earth's present surface.

Led by the observation that the Alpine Mountains were frequently composed of strata obliquely disposed, Saussure imagined, that the surface of the globe, formed by successive depositions and crystallizations, was originally covered by the ancient ocean; but that the crust bursting by the expansive force of heat, or of elastic fluids, the interior, or primitive parts of the crust were turned outwards, and supported by those of secondary formation. By the rapid retreat of the waters into the cavities thus formed, he accounts for the enormous blocks, now lieing in plains far distant from the rocks from which they were separated. After this retreat of the waters, he supposes that plants and animals were formed; and that since that period, several

immense currents have been caused by the opening of fresh gulfs, into which the waters have retreated at different periods; the last of which being that which reduced the waters to their present level.

Patrin formed the opinion, that in the beginning, all the matters which now compose the exterior part of the globe were held in solution, or suspension in a fluid; and that, of these, some were deposited in a crystallized state, as the granite, &c. whilst those which were not in a state of actual solution, formed the different schists and other earthy, saline, and metallic strata, regularly and concentrically disposed. Whilst thus existing in a soft and yielding state, the different substances, by acting on each other, he supposes to have passed into a state of fermentation, necessarily productive of a swelling or raising up, which taking place first of all in the granitic and saline pasty masses, these were elevated, carrying with them, or bursting through, the other strata, thus forming the rocks and mountains, now existing on the face of the earth.

That respectable and excellent mineralogist, Mr. Kirwan, has zealously endeavoured to form a system which may accord with the Mosaic account of the creation. He supposes the superficial parts of the globe to have been in a fluid state, being held in solution by water considerably heated. From the coalescing and crystallization of the contents of this solution, the various metallic substances, the different earths, &c. were deposited, in various combinations, forming, according to the predominant proportion of the ingredients, granite, gneiss, porphyry, and the other primeval rocks. By the crystallization of these immense masses, a prodigious quantity of heat was generated, even to incandescence, and the oxygen uniting with inflammable air, occasioned a stupendous conflagration, by this the solid basis on which the chaotic fluid rested, was rent to a great extent. From the extrication, by this heat, of the oxygen and nitrogen gases, the atmosphere was formed; and from the union of the oxygen with ignited carbon, carbonic acid proceeded, which being absorbed by calcarious earth, was precipitated in combination with it, forming the primitive limestones. The level of the ancient ocean becoming then lowered to the depth of 9000 feet, fish were created; and the various stratified secondary mountains were formed within it during its retreat, and after the creation of fish. Soon after, the higher tracts of land being left uncovered by the retreat of the sea to its bed, the land became supplied with vegetables and animals. The deluge, he considers as a miraculous effusion of water, both from the clouds and from the great abyss, which originated in, and proceeded from, the great southern ocean below the equator, and which rushing into the northern hemisphere, descended southwards, and at length spread over the face of the whole earth.

M. de la Metherie, who has investigated the subject with much attention, is of opinion, that all the mountains, vallies, and plains, composing the crust of the earth, were formed nearly in the state in which they now exist, by crystallization of the mass of water which surrounded the earth. The matters composing the highest mountains, he shows, have evidently been held in solution: the water, therefore, must have reached above their summits, and of course have stood 18,000 feet, at least, above its present level. But this being admitted, it becomes necessary to determine what has become of the immense quantity of water which has disappeared since that period. Of this he imagines, that some part has escaped by evaporation, and passed into other planets, but that by far the greatest part is buried in the immense caverns which exist in the interior part of the globe.

On reviewing the systems which have been just enumerated, it is obvious that some are so abundant in fanciful conjecture, and so deficient of probability, as not to require any further remark; whilst in others of a more specious appearance, there are some points which cannot be allowed to their ingenious authors. On these particular doubtful points, it is thought best to offer a few remarks, rather than separately examine each system. With respect to crystallization from an aqueous solution, a supposition which has not yet been generally adopted, it may be remarked, that the primitive mountains and vallies give exactly that irregularity of appearance, from lofty needle-like forms shooting up in some parts, and extensive plains existing in others, which are observable in cases of crystallization on the small scale. It has been objected that the secondary mountains do not every where cover the primary on which they rest; this circumstance must, in all probability, have depended on particular local circumstances, and especially on such as would, as in ordinary cases of crystallization, direct the formation of crystals more

numerously on one spot than on another. Particular currents may perhaps be considered among the causes which assisted in producing these effects, as well as in forming particular chains; whilst to the action of contrary currents may be attributed the formation of separate mountains. The formation of secondary mountains seems also to concur with what is generally observed in the ordinary progress of crystallization; where it is observed, that after one series of crystals are formed of the least soluble matters, others are then formed of those substances which the fluid was able to hold still longer in solution. It has been objected against this system of crystallization of rocks, &c. that nature seems to perform nothing of that kind at the present period; but were this the fact, the objection would not possess much force, since a most satisfactory answer might be yielded, by asserting that the operation has ceased, in consequence of the task being accomplished; and, speaking with respect to the granitic and porphyry rocks, all the materials being employed. The formation of stone by crystallization is, however, carrying on in various situations at the present moment; the incrustations formed in certain springs, and the various stalactitic formations which take place daily, are instances of this kind.

The unfitness of water to hold the substances forming the primitive rocks in solution, has been considered as a powerful objection; but it is to be considered, that the menstruum cannot be supposed to have been simple water, but, as Mr. Kirwan observes, this primitive fluid must have contained all the various simple saline substances and indeed every simple substance, variously distributed, "forming, upon the whole, a more complex menstruum than any that has since existed, and consequently endued with properties very different from any with which we have been since acquainted." Geological Essays, P. II.

Considerable difficulty must, however, continue in adapting any system which confines the production of the various geological phenomena which present themselves to our observation to too few and to too limited causes; since however necessary it may be to refer the general phenomena to the operation of one particularly powerful agent, it still must be neccessary to take into the reckoning the sinking and the raising of particular spots from subterraneous submarine fires; as well as the changes produced by the subversion of lofty mountains, rapid and violent currents of water, and various other powerful causes.

By the preceding sketch of the numerous systems which have been advanced, and by these cursory remarks on some of the objections which have been made against those which appear to possess the greatest share of probability, the mind becomes better prepared to attend to the system of the celebrated Werner, to whom, in the opinion of his learned and zealous annotator, we owe almost every thing that is truly valuable in this important branch of knowledge. For the purpose of conveying some notion of this ingenious system, the following sketch is taken from the view of it given in the "Elements of Geognosy," by Professor Jameson.

Agreeable to this system, the earth is supposed to have existed originally in a state of aqueous fluidity, which is inferred from its spheroidal form, and from the highest mountains being composed of rocks, possessing a structure exactly resembling that of those fossils which have, as it were, under the eye, been formed by water. From this circumstance it also follows that the ocean must have formerly stood very high over these mountains; and as these appear to have been formed during the same period of time, it follows, that the ocean must have formerly covered the whole earth at the same time. Contemplating the formations of the mountains themselves, Werner discovered the strongest proofs of the diminution of the original waters of the globe. He ascertained, 1st, that the outgoings (the upper extremities as they appear at the surface of the earth) of the newer strata are generally lower than the outgoings of the older, from granite downwards to the alluvial depositions, and this, not in particular spots, but around the whole globe. 2d. That the primitive part of the earth is entirely composed of chemical precipitations, and that mechanical depositions only appear in those of a later period, that is, in the transition class, and thence they continue increasing, through all the succeeding classes of rocks. This evidence of the vast diminution of the volume of water which stood so high over the whole earth, is assumed to be perfectly satisfactory, although we can form no correct idea of what has become of it.

By the earliest separations from the chaotic mass, which are discoverable in the crust of the globe, was formed a class of

rocks, which are therefore termed primitive rocks, being chiefly composed of silex, alumina, and magnesia, constituting by their various intermixtures, 1, granite; 2, gneiss; 3, mica-slate; 4, clay-slate; 5, primitive lime-stone; 6, primitive-trap; 7, serpentine; 8, porphyry; 9, sienite; 10, topaz rock; 11, quartz rock; 12, primitive flinty slate; 13, primitive gypsum; 14, white stone. The circumstances which chiefly mark the high antiquity of these rocks are, that they form the fundamental rock of the other classes; and that the outgoings of their strata are generally higher than those of the other classes. Having been formed in the uninhabitable state of the globe, they contain no petrifactions; and, excepting the small portion which sometimes accompany those which will be next mentioned, they contain no mechanical deposits, but are throughout pure chemical productions. Small portions of carbonaceous matter occur only in the newer members of the class.

Before the summits of the mountains appeared above the level of the ocean, and before the creation of vegetables and animals, a rising of the waters is supposed to have taken place, during which that class of rocks which are said to be of the second porphyry and sienite formation was deposited. The rocks of this formation are of clay-porphyry, pearl-stone porphyry, obsidian porphyry, sienite, and pitch-stone. They contain very little mechanical depositions, are of complete chemical formation, and contain little or no carbonaceous matter, and never any petrifactions.

On the appearance of land, or during the transition of the earth from its chaotic to its habitable state, rocks which, from this circumstance, are denominated transition rocks, were formed. In these rocks the first slight traces of petrifactions, and of mechanical depositions, are to be found. The species of rocks which come under this class are the transition lime-stone, transition-trap, grey-wacke, and flinty slate. The petrifications are corallites, encrinites, pentacrinites, entrochites, and trochites. The lime-stone of Derbyshire is said to be of this kind. As the former class of rocks were purely of chemical formation, so the contents of these are chiefly chemical productions, mingled with a small proportion of mechanical depositions. To explain the cause of this mixture, we are referred to the period of their formation, that at which the summits of the primitive mountains just appeared above the waters, when, by the attrition excited by the motion of the waves, and which we are reminded extends to no great depth, particles of the original mountains were worn off and deposited.

As the height of the level of the ocean diminished, so would the surface on which its waves acted increase, and of course the quantity of the mechanical depositions. Hence these are much more abundant in the rocks of the next formation, which are denominated flœtz rocks, on account of their being generally disposed in horizontal or flat strata. In these, petrifactions are very abundantly found, having been formed whilst vegetables and animals existed in great numbers. These rocks are generally of very wide extent, and commonly placed at the feet of primitive mountains. They are seldom of very great height, from whence it may be inferred, that the water had considerably subsided at the time of their formation, and did not then cover the whole face of the earth. Countries composed of these rocks are not so rugged in their appearance, nor so marked by rapid inequalities, as those in which the primitive and transition rocks prevail. The formations of this class are supposed to be, 1, first or old red sand-stone; 2, first or oldest flœtz lime-stone; 3, first or oldest flœtz gypsum; 4, second or variegated sand-stone; 5, second flœtz gypsum; 6, second flœtz or shell lime-stone; 7, third flœtz sand-stone; 8, Rock-salt formation; 9, chalk formation; 10, flœtz-trap formation; 11, independent coal formation; 12, newest flœtz-trap formation.

Most of the rocks which have been just enumerated are covered by a great formation, which is named the newest flœtz trap. This formation also covers many of the high primitive mountains: it has but little continuity, but is very widely distributed. It contains considerable quantities of mechanical deposits, such as clay, sand, and gravel. The remains both of vegetables and animals also occur very abundantly in these deposits. Heaps of trees and of parts of plants, and an abundance of shells and other marine productions, with the horns of stags, and great beds of bituminous fossils, point out the lateness of the period when this formation was deposited. In this formation several rocks occur which are also met with in other flœtz formations; but the following are supposed to be peculiar to this class, basalt, wacke, grey-stone, por-

phyry slate and trap tuff. These rocks are said to have been formed during the settling of the water consequent to a vast deluge, which is supposed to have taken place when the surface of the earth was covered with animals and vegetables, and when much dry land existed. From various appearances observed in these rocks it is concluded, that the waters, in which they were formed, had risen with great rapidity, and had afterwards settled into a state of considerable calmness.

The collections and deposits derived from the materials of pre-existing masses, worn down by the powerful agency of air and water, and afterwards deposited on the land or on the sea coasts, are termed alluvial, and are, of course, of much later formation than any of the preceding classes. These deposits may be divided into, 1. Those which are formed in mountainous countries, and are found in vallies, being composed of rolled masses, gravel, sand, and sometimes loam, fragments of ores, and different kinds of precious stones. 2. Those which occur in low and flat countries, being peat, sand, loam, bog iron ore, nagelflech, calc-tuff and calc-sinter: the three latter being better known by the names breccia, tufa, and stalactite.

In this ingenious system, in which so much knowledge of the subject prevails, and in which the marks of long and patient investigation are evident, a very close accordance with geological facts is generally observable. Some few difficulties however occur, particularly it seems with respect to the new trap formation; since although the appearances which this is intended to explain do not better agree with any other supposition, still the rising of the waters whilst they yet covered the summits of the primitive mountains, has much the appearance of a supposition made up for this particular purpose; and as, at the same time, it appears to be warranted by no other phenomena, it seems to require some further consideration, before it is fully admitted.

For more particular observations on the various characters, and on the different classes of rocks, see ROCKS.

GEOMETRA, in natural history, one of the families of the Phalæna genus of insects. See PHALÆNA.

GEOMETRY, in its original sense, related simply to the measurement of the earth, and was invented by the Egyptians, whose lands being annually inundated, required to be frequently measured out to the respective owners, so that each might repossess his property. It seems probable, that, in the operations attendant on that act of justice, many discoveries were made relating to the properties of figures, which gradually led on to an extension of the science, and to the cultivation of the arts of navigation and astronomy, which, indeed, first flourished in that quarter. We are rather in the dark as to many improvements made in the infancy of geometry, and its attendant speculations; many tracts of supposed value having been entirely lost, though some faint traces and fragments of their subjects, if not of their contents, have from time to time been discovered. The Grecians appear to have been enthusiasts in their reception of the new science; accordingly, we find that Thales, Pythagoras, Archimedes, Euclid, &c. exerted themselves to instruct their countrymen, and thus to prepare the way for the philosophy of Ptolemy, Copernicus, and others of the ancient school; and of Des Cartes, Leibnitz and the immortal Newton, in our more enlightened times. At present, geometry is justly considered to be the basis of many liberal sciences, and to be an indispensable part of the education of those who purpose exercising even the more mechanical arts to advantage.

We shall submit to our readers a general view of this most useful and fascinating attainment, and, by a gradual display of its rudiments, open the field to further advancement, which may be easily insured by consulting those authors who have become eminent for the display of whatever relates to the superior branches of geometry. In the first instance, we shall submit the following definitions, as laid down by Euclid in his Elements, recommending them to the serious attention of the student; they being absolutely necessary towards his competent appreciation and understanding of the succeeding propositions.

DEFINITIONS.

1. A point hath neither parts nor magnitude. 2. A line has length, without breadth. 3. The ends, or bounds, of a line are points. 4. A right line lies evenly between two points. 5. A superficies, or plane, has only length and breadth. 6. Planes are bounded by lines. 7. A plain superficies lies evenly and level between its lines. 8. A plain angle is formed by the meeting of two right lines. 9. When an angle measures 90 degrees, it is called a right angle. 10. When less than 90 degrees, it is said to be an acute

angle. 11. When more than 90 degrees, it is called an obtuse angle. 12. A term, or bound, implies the extreme of any thing. 13. A figure is contained under one or more bounds. 14. A circle is a plain figure, contained in one line, called the circumference, every where equally distant from a certain point within it. 15. That equi-distant point within the circle is called its centre. 16. A line passing from one side to the other of a circle, and through its centre, is the greatest line it can contain, and is called its diameter. 17. The diameter divides the circle into two equal and similar parts, called semicircles. 18. When a line shorter than the diameter is drawn from one point to another on the circumference of a circle, it is called a chord. 19. The part of the circle so cut off or divided by such line or chord is called an arc or segment. 20. Figures contained under right lines are called right-lined figures. 21. A figure having three sides is called a triangle. 22. If all the sides of a triangle are of the same length, it is called an equilateral triangle. 23. If all the sides and angles are unequal, it is called a scalene triangle. 24. If two of the sides are of equal length, it is called an isosceles, or equi-crural triangle. 25. If containing a right angle, it is called a right-angled triangle. 26. The long-side subtending, and opposite to, the right angle is called the hypothenuse. 27. When the two shortest sides of a triangle stand at a greater angle than 90 degrees, the figure is said to be "obtuse;" and when all the angles are acute, it is called an acute-angled triangle. 28. When two lines preserve an equal distance from each other in every part, they are said to be parallel. 29. Parallel lines may be either straight or curved, but can never meet. 30. A figure having four equal sides, and all the angles equal, is a square. 31. But if its opposite angles only be equal respectively, the figure will then be a rhombus, or lozenge. 32. When all the sides of a figure are right lines, and that the opposite sides are parallel and equal, it is called a parallelogram. 33. If the opposite sides are equal, the others being unequal, the figure is called a rhomboides. 34. Four-sided figures, unequal in all respects, are called trapezia. 35. Figures having more than four sides are called polygons, and are thus distinguished: with five sides, it is called a pentagon; with six, an hexagon; with seven, an heptagon; with eight, an octagon; with nine, an enneagon; with ten, a decagon; with eleven, an endecagon; with twelve, a dodecagon. 36. A solid has length, breadth, and thickness. 37. A pyramid is a solid standing on a base, of any number of sides, all of which converge from the base to the same point or summit. 38. When standing on a triangular base, it is called a triangular pyramid; on four, a square pyramid; on five, a pentagonal; and thus in conformity with the figure of its base. 39. Every side of a pyramid is a triangle. 40. A cone is found by the revolution of a triangle on its apex, or summit, and a point situated in the centre of its base; therefore a cone (like a sugar-loaf) has a base, but no sides, 41. A prism is a figure contained under planes, whereof the two opposite are equal, similar, and parallel; and all the sides parallelograms. 42. A sphere is a solid figure, generated by the revolution of a circle on its diameter, which is then called the axis. 43. A cube is a solid formed of six equal and mutually parallel sides, all of which are squares. 44. A tetrahedron is a solid contained under four equal, equilateral triangles. 45. A dodecahedron is a solid contained under twelve equal, equilateral, and equiangular pentagons. 46. An icosahedron is a solid contained under twenty equal, equilateral triangles. 47. A parallelopipedon is a figure considered under six quadrilateral figures or planes, whereof those opposite are respectively parallel. 48. Figures, or bodies, are said to be equal when their bulks are the same; and similar, when they are alike in form, though not equal. 49. Therefore similar figures or bodies are to each other in proportion to their respective areas or bulks. 50. The line or space on which a figure stands is called its base; its altitude is determined by a line drawn parallel to its base, and touching its vertex, or highest part. 51. A right-lined figure is said to be inscribed within another, when all its projecting angles are touched thereby. 52. The figure surrounding or enveloping another is said to be described around, or on it. 53. When a line touches a circle, and proceeds without cutting it, such line is called a tangent. 54. Any portion, less than a semicircle, taken out from a circle by two lines, or radii, proceeding from the centre, is called a sector.

Certain AXIOMS are likewise proper to be carried in mind; *viz.* 1. That things equal to one and the same thing are equal to one another. 2. If to equal things (or numbers) we add equal things, (or numbers) the whole will be equal. 3. If from equal things we

take equal things, the remainder will be equal, and the reverse in respect to unequal things. 4. The whole is greater than any of its parts. 5. Two right lines do not contain a space. 6. All the angles within a circle cannot amount to more nor less than 360 degrees, nor in a semi-circle to more nor less than 180 degrees. 7. The value, or measure, of an angle is not affected or changed by the lines whereby it is formed being either lengthened or shortened. 8. Two lines standing at an angle of 90 degrees from each other will not be affected by any change of position of the entire figure in which they meet, but will still be mutually perpendicular.

After thus much preparation, we may conclude the student to be ready to proceed in the solution of problems, which we shall study to exhibit in the most simple, as well as in a progressive manner.

PROBLEM I.

To describe an equilateral triangle upon a given line. Let A B (fig. 1.) be the given line, with an opening of your compasses equal to its length ; from each end, A and B, draw the arcs C D and E F, to whose point of intersection at C draw the lines A C and B C.

PROBLEM II.

To divide an angle equally. Fig. 2. Let B A C be the given angle, measure off equal distances from A to B, and from A to C ; then with the opening B C draw alternately from B and from C the arcs which intersect at D : a line drawn from A to D will bisect the angle B A C.

PROBLEM III.

To bisect a given line. Fig. 3. Let A B be the given line ; from each end (or nearer, if space be wanting), with an opening of your compasses rather more than half the length of A B, describe the arcs which intersect above at C, and below at D : draw the line C D, passing through the points of intersection, and the line A B will be divided into two equal parts. Observe, this is an easy mode of erecting a perpendicular upon any given line.

PROBLEM IV.

To raise a perpendicular on a given point in a line. Fig. 4. With a moderate opening of your compasses, and placing one of its legs a little above or below the given line, describe a circle passing through the given point A on the line B C ; then draw a line from the place where the circle cuts at D, so as to pass through E, the centre to F on the opposite side of the circle : the line F A will be the perpendicular required.

PROBLEM V.

From a given point to let fall a perpendicular on a given line. Fig. 5. From the given point A draw the segment B C, passing under the line D E ; bisect B C in F, and draw the perpendicular A F.

THEOREM VI.

The opposite angles made by intersecting lines are equal ; (fig. 6.) as is shown in this figure : *o*, *o*, are equal ; *p*, *p*, are equal ; *s*, *s*, are equal.

PROBLEM VII.

To describe a triangle with three given lines. Fig. 7. Let A B, B C, and C D, be the three given lines ; assume either of them, say A B, for a base, then with an opening equal to B C, draw the segment from the point B of the base, and with the opening C D make a segment from C : the intersection of the two segments will determine the lengths of the two lines B C and C D, and of the angle A B C.

PROBLEM VIII.

To imitate a given angle at a given point. Fig. 8. Let A B C be the given angle, and O the point on the line O D whereon it is to be imitated. Draw the line A C, and from O measure towards D with an opening equal to A B : then from O make a segment with an opening equal to B C, and from K make a segment with an opening equal to A C : their intersection at E will give the point through which a line from O will make an angle with O D equal to the angle A B C.

THEOREM IX.

All right lines severally parallel to any given line are mutually parallel, as shown in fig. 9, where A B, C D, E F, and G H, being all parallel to I K, are all parallels to each other severally.

N. B. They all make equal angles with the oblique line O P.

PROBLEM X.

To draw a parallel through a given point. Fig. 10. From the end, on any part of the given line A B, draw an oblique line to the

given point C. Measure the angle made by A B C, and return another of equal measurement upon the line B C, so as to make the angle B C D equal to A B C: the line C D will be parallel to the line A B. Or, as in fig. 11, you may from any points, say C D, in the line A B draw two semicircles of equal dimensions; the tangent E F will be parallel to A B. Or you may, according to Problem 5, draw a perpendicular from the given point to the given line, and draw another line through the given point at right angles with the perpendicular proceeding from it to the line whose parallel was to be made, and which will be thus found. See fig. 12.

THEOREM XI.

Parallelograms of equal base and altitude are reciprocally equal. Fig. 13. The parallelogram No. 1 is rectangular: No. 2 is inclined, so as to hang over a space equal to the length of its own base; but the line A B, which is perpendicular thereto, divides it into two equal parts: let the left half, A B E, be cut off, and it will, by being drawn up to the right, be found to fit into the dotted space A C D. This theorem might be exemplified in various modes; but we presume the above will suffice to prove its validity.

THEOREM XII.

Triangles of equal base and altitude are reciprocally equal. Fig. 14. As every parallelogram is divisible into two equal and similar triangles, it follows that the same rule answers for both those figures under the position assumed in this proposition: we have shown this by fig. 15.

PROBLEM XIII.

To make a parallelogram equal to a given triangle, with a given inclination or angle. Fig. 16. Let B A C be the given triangle, and E D F the given angle. On the line D F measure a base equal to B C, the base of the triangle. Take B G equal to half the altitude of the triangle for the altitude of the parallelogram, and set it off on the line E D. Draw F H parallel to E D, and H E parallel to D F, which will complete the parallelogram E F D H, equal to the triangle B A C.

PROBLEM XIV.

To apply a parallelogram to a given right line, equal to a given triangle, in a given right lined figure. Fig. 17. Let A B be the given line to which the parallelogram is to be annexed. Let C be the triangle to be commuted, and D the given angle. Make B E F G equal to C, on the angle E B G: continue A B to E: carry on F E to K, and make its parallel H A L, bounded by F H, parallel to E A: draw the diagonal H K and G M both through the point B; then K L; and the parallelogram B M A L will be equal to the triangle C, and be situated as desired.

PROBLEM XV.

To make a parallelogram, on a given inclination, equal to a right-lined figure. Fig. 18. Let A B C D be the right-lined figure, and F K H the given angle or inclination; draw the line D B, and take its length for the altitude, F K, of the intended parallelogram, applying it to the intended base line K M: now take half the greatest diameter of the triangle D C B, and set it off from K to M, and set off half the greatest diameter of the triangle D A B, and set it off from H to M: make G H and L M parallel to F K, and F G parallel to K H. The parallelogram F K G H will be equal in area to the figure A B C D, and stand at the given inclination or angle.

PROBLEM XVI.

To describe a square on a given line. Fig. 19. Raise a perpendicular at each end of the line A B equal to its length; draw the line C D, and the square is completed.

THEOREM XVII.

The square of the hypothenuse is equal to both the squares made on the other sides of a right-angled triangle. Fig. 20. This comprehends a number of the foregoing propositions, at the same time giving a very beautiful illustration of many. Let A B C be the given right-angled triangle; on each side thereof make a square. For the sake of arithmetical proof, we have assumed three measurements for them: *viz.* the hypothenuse at 5, one other side at 4, and the last at 3. Now the square of 5 is 25. The square of 4 is 16, and the square of 3 is 9: it is evident the sum of the two last sides make up the sum of the hypothenuse's square; for 9 added to 16 make 25. But the mathematical solution is equally simple and certain. The squares are lettered as follow: B D C E, F G B A, and A H G K. Draw the following lines: F C, B K, A D, A L, and A E. We have already shown, that parallelograms and triangles of equal base and altitude are respectively equal.

The two sides F B, B C, are equal to the two sides A B, B D, and the angle D A B is equal F B C: the triangle A B D must therefore be equal to the angle F B C. But the parallelogram B L is double the triangle A B D. The square G B is also double the triangle F B C: consequently the parallelogram B L is equal to the square G B. The square H C in like manner is proved to be equal to the parallelogram C L, which completes the solution. Euclid, 47th of 1st Book.

PROBLEM XVIII.

To divide a line so that the rectangle contained under the whole line, and one segment, be equal to the square of the other segment. Fig. 21. On the given line A B describe the square A B C D; bisect A C in E, and with the distance E B extend A C to F, measuring from E. Make on the excess F A the square F H, and continue G H to K. The square F H will be equal to the parallelogram H D.

PROBLEM XIX.

To make a square equal to a given right-lined figure. Fig. 22. Let A be the given right-lined figure: commute it to a parallelogram, B D, as already shown (prob. 15.): add the lesser side E D to B E, so as to proceed to F: bisect B F in G, and from that point describe the semicircle B H F. Continue D E to H, which will give H E for the side of a square equal in area to the parallelogram B D, and to the original given figure A.

PROBLEM XX.

To find the centre of a given circle. Fig. 23. Draw at pleasure the chord A B, bisect it in D by means of a diameter, which being bisected will give F for the centre of the circle.

PROBLEM XXI.

To complete a circle upon a given segment. Fig. 24. Let A B C be the given segment: draw the line A C, and bisect it in D; draw also the perpendicular B E through D, draw B A, and on it make the angle B A E, equal to D B A; this will give the point of intersection E for the centre, whence the circle may be completed. It matters not whether the segment be more or less than a semicircle.

PROBLEM XXII.

To cut a given circumference into two equal parts. Fig. 25. Draw the line A B, bisect in C; the perpendicular D C will divide the figure into two equal and similar parts.

PROBLEM XXIII.

In a given circle to describe a triangle equiangular to a given triangle. Fig. 26. Let A B C be the circle, and D E F the triangle given. Draw the line G H, touching the circle in A: make the angle H A C equal to D E F, and G A B equal to D F E: draw B C, and the triangle B A C will be similar to the triangle D E F.

PROBLEM XXIV.

About a given circle to describe a triangle similar to a given triangle. Fig. 27. Let A B C be the given circle, and D E F the given triangle: continue the line E F both ways to G and H, and having found the centre, K, of the circle, draw a radius, K B, at pleasure; then from K make the angle B K A equal to D E C, and B K C equal to D F H; the tangents L N perpendicular to K C, M N perpendicular to K B, and M L perpendicular to K A, will form the required triangle.

PROBLEM XXV.

To describe a circle about a given triangle. Fig. 28. In the given triangle A B C, bisect any two of the angles; the intersection of their dividing lines, B D and C D, will give the centre D, whence a circle may be described about the triangle, with the radius D C.

PROBLEM XXVI.

To inscribe a circle in a given triangle. Fig. 29. In the triangle A B C, divide the angles A B C, and B C A, equally by the lines B D, C D. Their junction at D, will give a point whence the circle E C F may be described, with the radius D F perpendicular to B C.

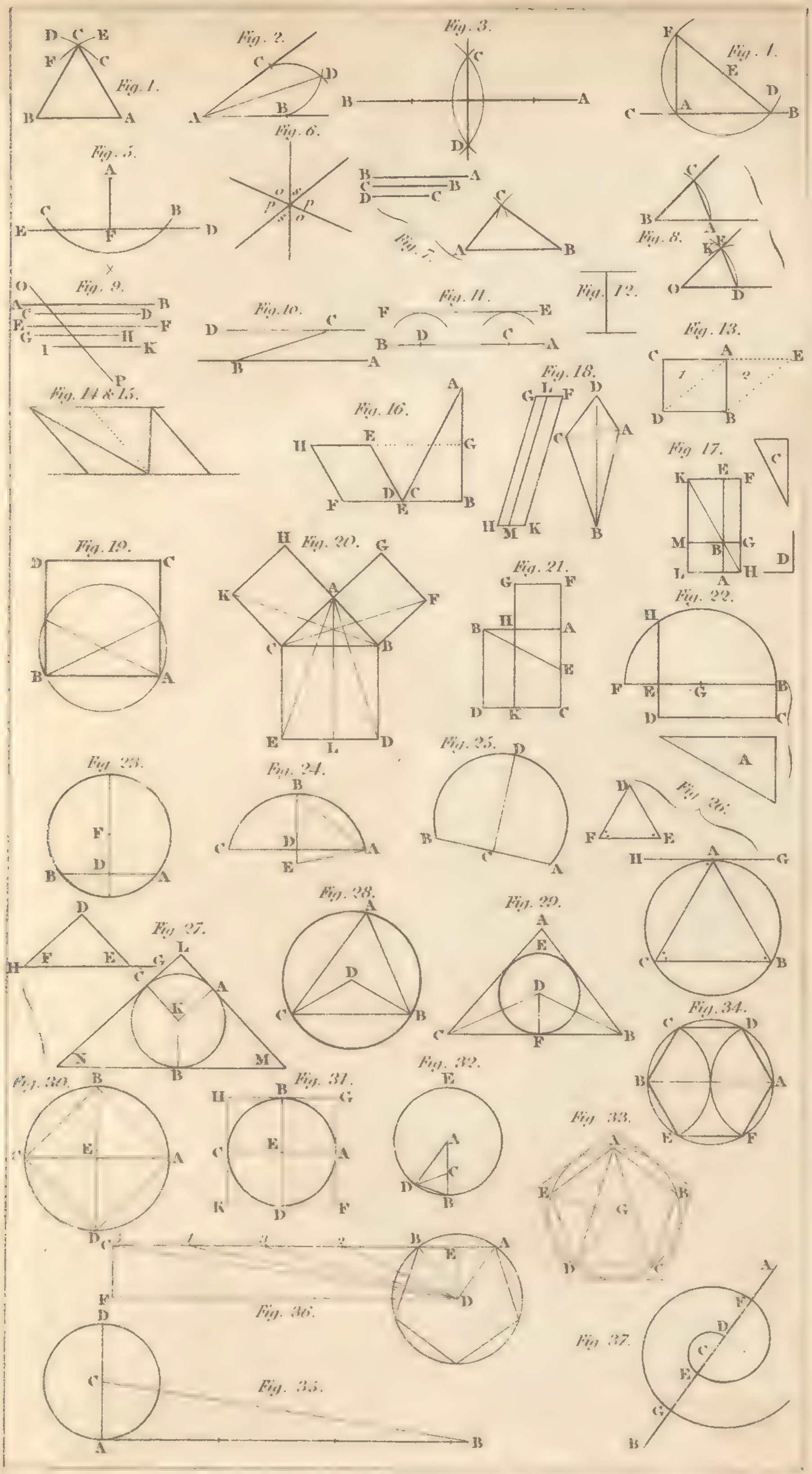
PROBLEM XXVII.

To inscribe a square in a given circle. Fig. 30. Draw the diameter A C, and, perpendicular thereto, the diameter B D: the lines A B, B C, C D, and D A, will form a correct square.

PROBLEM XXVIII.

To describe a circle around a square. Fig. 30. In the square A B C D, draw the diagonals A C, B D, their intersection at E will give the centre of a circle, whose radius may be any one of the four converging lines; say E A, that will enclose the square.

GEOMETRY.



Lowry sculp

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PROBLEM XXIX.

To describe a circle within a given square. Fig. 31. Divide the square into four equal parts, by the lines A C, B D, whose intersection at E, shows the centre of a circle to be drawn with any one of the converging lines, say E A, as a radius.

PROBLEM XXX.

To describe a square on a given circle. Fig. 31. Divide the circle into four equal parts, (or quadrants) by the lines A C, B D; draw the tangents G H, F K, parallel to A C, and G F, H K, parallel to B D; which will give the required square.

PROBLEM XXXI.

To make an isosceles triangle, having each of the angles at the base double that at the summit. Fig. 32. Cut any given line, as A B, into extreme and mean proportions, (as in Problem 18); then, from A, as the centre, draw a circle B D E, with the opening A B, and apply the line B D within its circumference, equal to A C, the greater portion of A B; join C D, A B D will be the isosceles triangle sought.

PROBLEM XXXII.

To describe a regular pentagon. Fig. 33. Make the isosceles triangle A C D within the circle A B C D E; the base C D will give the fifth part of the circumference.

PROBLEM XXXIII.

To describe a regular pentagon about a circle. Fig. 33. This is done by drawing parallels to the lines A B, B C, C D, D E, E A; making them all tangents to the circle; on the same principle, a square, a hexagon, &c. may be drawn around a circle, from a similar figure inscribed within it.

PROBLEM XXXIV.

To describe a circle around a pentagon. Fig. 33. Bisect any two angles of a pentagon, and take their point of intersection, G, as a centre, using either of the converging lines, D G, or E G, for a radius. Where a circle is to be described within a pentagon, you must bisect any two of the faces, and raise perpendiculars at those points, which will meet in the centre either of the converging lines serving for a radius.

PROBLEM XXXV.

To inscribe a regular hexagon within a circle. Fig. 34. The radius of a circle being equal to one-sixth of its circumference, establishes a very easy mode of setting off the six sides as follows: draw the diameter A B, set one leg of your compasses at A, and draw the segment D F, and from B draw the segment C E; thus dividing the circle into six equal portions; draw lines joining them, and the figure will be complete.

PROBLEM XXXVI.

To form a quindecagon, or figure of 15 equal sides, within a circle. An equilateral triangle being inscribed within a circle, by assuming the distance between three points of a hexagon, say from A to C in the last figure for a side, let one point of such triangle be applied to each angle of a pentagon in succession; its two other points will divide the opposite sides in three equal parts, as the figure changes place within the pentagon.

PROBLEM XXXVII.

To change a circle to a triangle. Fig. 35. Draw the tangent A B equal to 3½ diameters A D of the circle, and from the centre C draw C B, and C A: the triangle C A B will be equal in contents to the circle A D.

PROBLEM XXXVIII.

To change a pentagon into a triangle. Fig. 36. Continue the base line A B to C, and from the centre D let a perpendicular fall on A B, bisecting it in E. Measure from B a space equal to four times E B. Through the centre D draw D F, parallel and equal to E C; draw F C: the parallelogram contained under E C D F will equal the area of the pentagon. Or the pentagon may be changed to a triangle by adding to A B four times its own length, and drawing a line from the centre, to the produced termination of A B; the angle at the centre would then be obtuse.

PROBLEM XXXIX.

To draw a spiral line from a given point. Fig. 37. Draw the line A B through the given point C, and from C draw the semicircle D E, then shift to D for a centre, and make the semi-circle A E in the opposite side of the line: shift again from D to C for a centre, and draw the semi-circle F G; and then continue to change the centres alternately, for any number of folds you may require; the centre C serving for all above, the centre D for all below, the line A B.

With respect to the application of geometry to its pristine intent, namely, the mea-

surement of land, we must refer our readers to SURVEYING; under which head it will be found practically exemplified. We trust sufficient has been here said to show the utility and purposes of this important science, and to prove serviceable to such persons as may not have occasion for deep research, or for extensive detail.

GEORGIC, a poetical composition upon the subject of husbandry, containing rules therein, put into a pleasing dress, and set off with all the beauties and embellishments of poetry.

GEORGINA, in botany, a genus of the Syngenesia Superflua class and order. Receptacle chaffy; no down; calyx double; the outer many-leaved; inner one-leaved, eight-parted. There are three species.

GERANIUM, in botany, *crane's bill*, a genus of the Monadelphia Decandria class and order. Natural order of Gruinales. Gerania, Jussieu. Essential character: calyx five-leaved; corolla five-petalled, regular; nectary five honied glands, fastened to the base of the longer filaments; fruit five-grained, beaked; beaks simple, naked, neither spiral nor bearded. There are thirty-two species.

GERARDIA, in botany, so called in honour of John Gerarde, our old English botanist, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-cleft; corolla two-lipped, lower lip three-parted, the lobes emarginate, the middle segments two-parted; capsule two-celled, gaping. There are ten species.

GERMINATION. When a seed is placed in a situation favourable to vegetation, it very soon changes its appearance; the radicle is converted into a root, and sinks into he earth; the plumula rises above the earth, and becomes the trunk or stem. When these changes take place, the seed s said to germinate; the process itself has een called germination, which does not lepend upon the seed alone; something exernal must affect it. Seeds do not germiate equally and indifferently in all places nd seasons, they require moisture and a ertain degree of heat, and every species f plant seems to have a degree of heat eculiar to itself, at which its seeds begin ɔ germinate; air also is necessary to the ermination of seeds; it is for want of air ıat seeds which are buried at a very great epth in the earth, either thrive but indifferently, or do not rise at all. They frequently preserve, however, their germinating virtues for many years within the bowels of the earth; and it is not unusual, upon a piece of ground being newly dug to a considerable depth, to observe it soon after covered with several plants which had not been seen there in the memory of man. Were this precaution frequently repeated, it would perhaps be the means of recovering certain species of plants which are regarded as lost; or which, perhaps, never coming to the knowledge of botanists, might hence appear the result of a new creation. Light is supposed to be injurious to the process which affords a reason for covering seeds with the soil in which they are to grow, and for carrying on the business of malting in darkened apartments; malting being nothing more than germination, conducted with a particular view.

GEROPOGON, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ, or compound flowers, with semi-florets or ligulate florets only. Cichoraceæ, Jussieu. Essential character: calyx simple; receptacle with bristle-shaped chaffs; seeds of the disk, with a feathered down of the ray, with five awns. There are three species.

GESNERIA, in botany, so named in honour of Conrad Gesner, of Zurich, the famous botanist and natural historian, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Campanulaceæ, Jussieu. Essential character: calyx five-cleft, sitting on the germ; corolla incurved and recurved; capsule inferior, two-celled. There are twelve species.

GETHYLLIS, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Spathaceæ. Narcissi, Jussieu. Essential character: calyx none; corolla six-parted; berry club-shaped, radicle, one-celled. There are four species.

GEUM, in botany, English *avens*, or *herb bennet*, a genus of the Icosandria Polygynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx ten-cleft; petals five; seeds with a kneed awn. There are nine species, natives of Europe and North America.

GHINIA, in botany, so named in memory of Lucas Ghini, a famous physician and botanist of Bologna, a genus of the Diandria Monogynia class and order Na-

tural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-toothed, teeth acuminate; corolla two-lipped; stamina four, with two barren anthers at the end of the shorter filaments; pericarpium a drupe containing four or five celled nut, with a seed in each cell. There are two species.

GIANT'S *causeway*, a vast collection of a black kind of marle, called basaltes, in the county of Antrim, in Ireland. See BASALTES, and STAFFA.

GIBBOUS, in astronomy, a term used in reference to the enlightened parts of the moon, whilst she is moving from the first quarter to the full, and from the full to the last quarter: for all that time the dark part appears horned, or falcated; and the light one hunched out, convex or gibbous.

GIFT, in law, a transferring the property in a thing from one to another without a valuable consideration; for to transfer any thing upon a valuable consideration, is a contract or sale. He who gives any thing is called the donor, and he to whom is given is called the donee. By the common law all chattels, real or personal, may be granted or given without deed, except in some special cases, and a free gift is good without a consideration, if not to defraud creditors. But no leases, estates, or interests, either of freehold or term of years, on any uncertain interest, not being copyhold or customary interest of, in, to, or out of any messuages, manors, lands, tenements, or hereditaments, shall at any time be assigned, granted, or surrendered, unless it be by deed or note in writing, signed by the party so assigning, granting, or surrendering the same, or their agents thereunto lawfully authorized by writing, or by act and operation of law. 29 Car. II. c. 3. A gift of any thing, without a consideration, is good, but it is revocable before delivery to the donee, of the thing given.

GILBERTIA, in botany, a genus of the Decandria Monogynia class and order. Calyx five-toothed; corolla deeply five-parted; nectary deeply ten-parted, with lanceolate segments; antheræ sessile, in the segments of the nectary; fruit six-celled. Only one species, G. racemosa, found in Peru; branches reddish and downy; leaves alternate, elliptic, acute, entire, reddish, downy underneath; racemes axillary.

GILD, or GUILD. See GUILD.

GILDING, *art of*. The art of gilding or of laying a thin superficial coating of metal on wood, metal, and other substances, has been long practised and highly esteemed, both for its utility and the splendid effect which it produces. Gold, from the extreme beauty of its colour, and from the length of time during which it may be exposed to the action of the air without tarnishing, is perhaps the most valuable of all substances for the purpose of decoration; but on account of its dearness and weight, it can very seldom be employed in substance, and its ornamental use would be limited, indeed, if it were not at the same time the most extensible of all substances; so that a given weight of gold, notwithstanding its high specific gravity, may, by beating, be made to cover a larger surface than an equal quantity of any other body. Among the ancients, the Romans, and among the moderns, the French have been remarkable for their large and profuse consumption of gold; not only the temples, theatres, and other public buildings, being adorned with gilding, but even the private houses of the wealthier classes.

The materials for gilding, or rather the different states in which gold is used for the purpose, are the following: leaf-gold of different thicknesses, and formed either of the pure metal, or of an alloy of this with silver, amalgam of gold, and gold-powder. The leaf-gold is procured by the gilder from the gold-beater, for an account of which we shall refer the reader to the article GOLD; but the other two substances being prepared by the gilder himself, may be with propriety described here. The amalgam of gold is made, by heating in a crucible some pure quicksilver; and when it is nearly boiling, adding to it about a sixth of its weight of fine gold in thin plates, heated red hot; the mixture, after being kept hot for a few minutes, becomes of a perfectly homogeneous consistence, and may then be allowed to cool: when cold, it is to be put in a piece of soft leather, and by gradual pressure, the fluid part of the amalgam, consisting almost wholly of mercury, may be forced through the pores of the leather, while the gold combined with about twice its weight of mercury will remain behind, forming a yellowish silvery mass of about the consistency of soft butter. This, after being bruised in a mortar, or shaken in a strong phial, with repeated portions of salt and water, till the water ceases to be fouled by it, is fit for use, and may be kept for any length of time without injury in a corked phial. It is of essential importance that the materials of this amalgam, and especially the mercury,

should be perfectly pure, as the least portion of lead or bismuth would very materially injure the beauty of the gilding, by deteriorating the colour of the gold, and filling it with black specks; on this account no mercury ought to be employed that has not been procured by distillation from the red precipitate (nitrous red oxide of mercury) either alone or mixed with a little charcoal powder.

Gold is prepared in three different ways. The first and simplest is to put into a glass or earthern mortar some gold-leaf, with a little honey or thick gum-water, and grind the mixture for a considerable time, till the gold is reduced to extremely minute fragments; when this is done, a little warm water will wash out the honey or gum, leaving the gold behind in a flaky pulverulent state. A less tedious and more effectual way of comminuting the gold, is to dissolve it in nitro-muriate acid, and then precipitate it with a piece of copper: the precipitate, after being digested in distilled vinegar, and then washed in water and dried, is in the form of a very fine powder, and both works better, and is easier to burnish than the ground leaf-gold. The finest ground gold is however produced by heating very gradually the gold-amalgam in an open earthern vessel, and continuing the fire till the whole of the mercury is evaporated, taking care that the amalgam shall be constantly stirred with a piece of glass, rod, or tobacco-pipe, in order to prevent the particles of gold from adhering as the mercury flies off. When the mercury is completely evaporated, the residual gold being then ground in a Wedgewood-ware mortar, with a little water, and afterwards dried, it is fit for use.

Gilding is performed either with or without heat. By the first of these methods those substances are gilt which are not liable to alteration by exposure to a moderate heat, such as metals, and sometimes glass and porcelain: the second method is practised with those substances, such as wood, paper, lead, silk, lacquered and japanned ware, &c. which would be injured and even destroyed at the temperature requisite for gilding the former. The last of these methods being the simplest, shall be first described, and we shall begin with the art of gilding on wood.

There are two methods for gilding on wood, namely, oil gilding and burnished gilding. Oil gilding is thus performed: the wood must first be covered, or primed, with two or three coatings of boiled linseed oil and white-lead, in order to fill up the pores and to conceal the irregularities of the surface, occasioned by the veins in the wood. When the priming is quite dry, a thin coat of gold-size must be laid on. This is prepared by grinding together some strongly calcined red ochre with the thickest drying oil that can be procured, and the older the better: that it may work freely, it is to be mixed previously to being used with a little oil of turpentine, till it is brought to a proper consistence. If the gold-size is good, it will be sufficiently dry in twelve hours, more or less, to allow the artist to proceed to the last part of the process, which is the application of the gold. For this purpose a leaf of gold is spread on the cushion (formed by a few folds of flannel secured on a piece of wood, about eight inches square, by a tight covering of leather), and is cut into strips of a proper size by a blunt pallet-knife; each strip being then taken up on the point of a fine brush, is applied to the part intended to be gilded, and is then gently pressed down by a ball of soft cotton; the gold immediately adheres to the sticky surface of the size, and after a few minutes the dexterous application of a large camels' hair brush sweeps away the loose particles of the gold leaf without disturbing the rest. In a day or two the size will be completely dried, and the operation is finished. The advantages of this method of gilding are, that it is very simple, very durable, not readily injured by changes of weather, even when exposed to the open air, and when soiled it may be cleaned by a little warm water and a soft brush: its disadvantage is, that it cannot be burnished, and therefore wants the high lustre produced by the next method. Its chief employment is in outdoor work.

Burnished gilding, or gilding in distemper, is thus performed. The surface to be gilt must be carefully covered with strong size, made by boiling down two pieces of white leather, or clippings of parchment, till they are reduced to a stiff jelly; this coating being dried, eight or ten more must be applied, consisting of the same size, mixed with fine Paris-plaster or washed chalk; when a sufficient number of layers have been put on, varying according to the nature of the work, and the whole is become quite dry, a moderately thick layer must be applied, composed of size and bole, or yellow ochre: while this last is yet moist, the gold leaf is to be put on in the usual

manner; it will immediately adhere on being pressed by the cotton ball, and before the size is become perfectly dry, those parts which are intended to be the most brilliant are to be carefully burnished with agate or dog's-tooth. In order to save the labour of burnishing, it is a common, but bad practice, slightly to burnish the brilliant parts, and to deaden the rest by drawing a brush over them dipped in size: the required contrast between the polished and the unpolished gold is indeed thus obtained; but the general effect is much inferior to that produced in the regular way, and the smallest drop of water falling on the sized part occasions a stain. This kind of gilding can only be applied on in-door work, as rain, and even a considerable degree of dampness, will occasion the gold to peel off. When dirty, it may be cleaned with a soft brush, and hot spirit of wine, or oil of turpentine. It is chiefly used on picture frames, mouldings, and stucco.

Letters written on vellum or paper are gilded in three ways: in the first, a little size is mixed with the ink, and the letters are written as usual; when they are dry, a slight degree of stickiness is produced by breathing on them, upon which the gold leaf is immediately applied, and by a little pressure may be made to adhere with sufficient firmness. In the second method, some white-lead or chalk is ground up with strong size, and the letters are made with this by means of a brush: when the mixture is almost dry, the gold leaf may be laid on, and afterwards burnished. The last method is, to mix up some gold powder with size, and make the letters of this by means of a brush. The edges of the leaves of books are gilded, while in the binder's press, by first applying a composition formed of four parts of Armenian bole, and one of sugar candy, ground together to a proper consistence, and laying it on with a brush with the white of egg: this coating, when nearly dry, is smoothed by the burnisher; it is then slightly moistened with clean water, and the gold leaf applied, and afterwards burnished. In order to impress the gilt figures on the leather covers of books, the leather is first dusted over with very fine rezin, or mastich, then the iron tool by which the figure is made is moderately heated, and pressed down on a piece of leaf gold which slightly adheres to it, being then immediately applied to the surface of the leather with a certain force, the tool at the same time makes an impression, and melts the mastich which lies between the heated iron and the leather; in consequence of this the gold with which the face of the tool is covered is made to adhere to the leather, so that on removing the tool a gilded impression of it remains behind.

Drinking glasses and other utensils of this material, are sometimes, especially in Germany, gilt on their edges: this is done in two ways, either by a simple adhesive varnish or by means of fire. The varnish is prepared by dissolving in drying linseed oil, a quantity of gum amine, or still better of clear amber, equal in weight to the linseed oil; a very drying and adhesive varnish is thus prepared, which being diluted with a proper quantity of oil of turpentine is to be applied as thin as possible to those parts of the glass which are intended to be gilded; when this is dry, which will be about a day, the glass is to be placed by the fire side, or in a stove till it is so warm as almost to burn the fingers when handled; at this temperature the varnish will become glutinous, and a piece of gold leaf applied in the usual way will immediately adhere; when the gilding is thus put on, and before it is grown quite cold it may be burnished, taking care only to interpose a piece of very thin paper betwen the gold and the burnisher. If the varnish is very good this is the best method of gilding glass, as the gold is thus fixed on more evenly than in any other way: it often happens, however, that when the varnish is but indifferent, that by repeated washing the gold soon wears off: on this account the practice of burning it in, is sometimes had recourse to.

For this purpose some gold powder is tempered with borax, and in this state applied to the clean surface of the glass, with a clean camels' hair pencil; when quite dry the glass is put in a stove heated to about the temperature of an annealing oven, the gum burns off, and the borax by vitrifying cements the gold with great firmness to the glass; after which it may be burnished. The gilding upon porcelain is in like manner fixed by fire and borax; and this kind of ware being neither transparent nor liable to soften, and thus injure its form in a low red heat, is free from the risk and injury, which the finer and more fusible kinds of glass are apt to sustain from such treatment.

All the methods of gilding hitherto described resemble each other by being accomplished by means of some adhesive medium; this, however, is not the case with

gilding upon metals, the gold is brought into immediate contact with the other metal and they both remain firmly united merely by the attraction of adhesion subsisting between them. The simplest of all the kinds of gilding on metal, and which strikingly demonstrate the power of the affinity of adhesion, is one which is sometimes practised on plane surfaces of copper and iron, with considerable success. The metal being previously polished is heated to about the temperature of melted lead, and covered with a double layer of gold leaf: by the cautious application of a blood stone burnisher applied gently at first, and increasing the force of the pressure by degrees, the surface of the gold and copper are brought to touch each other in almost every point, and then adhere with a force proportionate to the completeness of the contact. The first layer being thus burnished down, a second is made to adhere in the same manner, and sometimes a third, if the gilding is intended to be very solid. The objection to this kind of gilding is its tediousness and the almost impossibility of using a sufficient pressure without injuring the evenness of the gilded surface: where these objections do not apply there cannot be a more effectual mode of gilding as is evident from the manufacture of gilt silver and copper wire. The bar, before it is committed to the wire-drawer, is plated with gold, by having several plates of gold successively burnished down upon it, and being then subjected to the stronger compression which takes place in wire-drawing, the gold and the other metal become so perfectly united as to form in a manner but one substance.

The most usual method of covering the face of a metal with gold, is by means of an amalgam, or, as it is technically called, water-gilding. If the metal to be gilt is silver, the best method of proceeding is first to soak it in warm dilute muriatic acid, that the surface may be rendered perfectly clean; it must then be washed in clean water, changed two or three times, to get rid of the whole of the acid: being afterwards dried, and made moderately warm, a little gold amalgam, also warm, is to be carefully and evenly spread upon the silver, to which it will immediately adhere: when this is completed, the piece is placed upon a convenient support over a charcoal fire, and while the mercury is evaporating, if any specks or places appear, which have escaped the amalgam, a small piece is to be laid on, and spread with a brush, to supply the deficiency, without removing the article from the fire. After a time, the whole of the mercury will be driven off, and the piece, after cooling, being accurately examined, will be found to be entirely covered with a thin coating of pale dull gold. The small roughnesses, and loosely-adhering particles, are now to be removed with a scratch-brush, which is made of some extraordinary fine brass wire, bound together into a tuft; by it the surface is rendered perfectly smooth and bright; but it still remains of a pale yellowish colour: this defect is next removed by warming the piece, and smearing it over with gilders' wax, a composition of bees' wax, red ochre, verdigris, and green vitriol or alum. The wax being burnt off over a charcoal fire, and the piece quenched in urine, the colour of the gilding will be found to be much heightened; if it is not sufficiently so, the application of a succeeding one will complete the desired effect, after which the work may be burnished or not, according to the taste of the artist. Instead of the common gilders'-wax, a mixture of equal parts of nitre, sal-ammoniac, green vitriol, and verdigris, moistened with water, will answer the purpose.

Copper, and the alloys formed by its combination with zinc, are gilded nearly in the same manner as silver; but, as their affinity for mercury is considerably less than that of silver, it would be difficult to make the amalgam of gold adhere to the burnished surface of these metals by the same means, and with the same evenness, as takes place in the last case described. To obviate this inconvenience, advantage is very ingeniously taken of the action of nitric acid to facilitate the adhesion of the copper and mercury, in the following manner. A piece of copper, a button for example, if cleaned, by steeping it in acid, and subsequent washing, and is then burnished either in a lathe, or by any other means: after this it is dipped in a neutralized solution of nitrate of mercury, and in the space of a few minutes, owing to the strong affinity of nitric acid for copper, the mercurial salt is decomposed, the copper takes the place of the mercury, and at the same time the mercury is deposited in the metallic state on the surface of the copper, covering it entirely, and strongly adhering to it; the gold amalgam is now applied, and the rest of the process goes on as already described. By this method of proceeding, a given quantity of gold

may be made to cover a larger surface than in any other way of gilding on metals; five grains of gold will completely gild both the upper and under surfaces of one-hundred and forty-four copper buttons each of them an inch in diameter.

There is no metal, the gilding of which presents so many difficulties as iron, or rather steel. If the method of simple burnishing down is had recourse to, the heat requisite for this purpose will, in many cases, bring the temper of the steel too low: on such occasions, the way already described for gilding on copper, is sometimes practised; that is, the parts of the steel to be gilded, are pencilled over with nitrate of mercury, by which they are covered with a slightly-adhering coat of mercury; then the amalgam is applied, and the gilding finished in the usual way. The objections to this mode of proceeding are, first, that a considerable heat is required, though inferior to that requisite for burnishing down; and secondly, that even with all possible care the gilding is apt to be rough and scale off. A very considerable improvement in this way of gilding is to trace the figure of the gilding on the steel first of all, with a brush charged with a strong solution of sulphated copper, in consequence of which a pretty thick plate of this metal is deposited on the steel, to which it may be made to adhere, with considerable firmness, by means of the burnisher; thus the gilding is, in fact, performed upon the copper.

A new method of gold-gilding upon steel has lately been published, possessed of many advantages over the others, and probably in time may attain to a very high degree of perfection. It depends upon the well-known fact, that if sulphuric ether and nitro-muriate of gold are mixed together, the ether will, by degrees, separate from the acid nearly the whole of the gold, and retain it for some time in solution, in nearly a metallic state. If ether, thus charged with gold, is spread, by means of a pen or fine brush, on the surface of highly-polished steel, the ether presently evaporates, leaving the gold behind in close contact with the steel, and the adhesion is considerably improved by the subsequent application of the burnisher. The dearness, and especially the rapid volatility of ether, are, at first, objections of some moment, but may be got over by using the best oil of turpentine instead of ether, which has nearly the same efficacy in decomposing the nitro-muriate of gold, and is both cheaper, and not so very quickly evaporable.

Gold-gilding upon silver is, we believe, at present entirely disused. It was performed in the following manner: a saturated solution of gold, in nitro-muriatic acid, was poured upon some linen rags, and when they were become dry, they were heaped in a plate, and touched with a hot coal. The fire gradually spread through the mass, and reduced it to a heavy black ash. A soft cork, being moistened in water, was dipped in this ash, to which a part of it adhered, and was then rubbed on the surface of polished silver, upon which the minute particles of gold became fixed, and covered it with an extremely thin coating, which, when burnished, exhibited the genuine colour and lustre of the precious metal. *Aikin's Dict.*

GILL, a measure of capacity, containing a quarter of a pint.

GILT *varnish.* See VARNISH.

GIMBALS, in sea affairs, the brass rings by which a sea compass is suspended in its box, so as to counteract the effect of the ship's motion, and keep the card horizontal.

GIMBLETING, a term applied to the anchor to denote the action of turning it round by the stock, so that the motion of the stock appears similar to that of the handle of a gimblet when it is employed.

GIN. See GENEVA.

GIN, in mechanics, a machine for driving piles, fitted with a windlass and winches at each end, where eight or nine men heave, and round which a rope is reeved, that goes over the wheel at the top.

GINANNIA, in botany, a genus of the Enneandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx double, both one-leafed; petals three, fringed, spreading; germ pedicelled, with a membranaceous wing at top; legume. There is but one species, *viz.* G. guianensis, a shrub about fifteen feet high; a native of the forests of Guiana.

GINGER, in botany. See ZINZIBER.

GINORA, in botany, so called in honour of the Marquis Carlo Ginori, a genus of the Dodecandria Monogynia class and order. Natural order of Salicariæ, Jussieu. Essential character: calyx six-cleft; petals six; capsule one-celled, four-valved, coloured, containing many seeds. There is but one species, *viz.* G. Americana, an elegant little shrub about four feet high; it is

a native of Cuba, by river sides, and called there rosa del rio, or river rose.

GINSENG, in botany. See PANAX.

GIRDERS, in architecture, some of the largest pieces of timber in a floor. Their ends are usually fastened into summers and breast-summers, and joists are framed in at one end to the girders. The size of girders and summers, upon the rebuilding of London, were ordained by act of Parliament, to be in length from ten to twenty-six feet, in breadth from eleven to seventeen inches, and in depth from eight to fourteen inches. It was also ordained by the same statute, that no girder or summer should be less than ten inches in the wall, and that their ends should be laid in loam; as also that they be of good hearty oak, as free from knots as may be, because that will be the least subject to breaking, and may with more safety be relied on in this cross and transverse work.

GIRT, in the measuring of timber, is the circumference of a tree, though some use this word for the fourth part of the circumference only, on account of the use made of it. The square of the fourth part is considered as equal to the area of the section of the tree, which square therefore multiplied by the length of the tree is accounted the solid content. This content is about one fourth less than the true quantity, being nearly equal to what it will be after the tree is hewn square, and is probably intended to make an allowance for the squaring the tree.

GIRT, in naval affairs, the situation of a ship which is moored so tight by her cables as to be prevented turning to any change of the wind or tide, to the current of which her head would otherwise be directed. The cables, to produce this, are extended by a strong application of mechanical powers within the ship, so that as she veers, or endeavours to swing about, her side bears upon one of the cables, which interrupts her in the act of traversing.

GIRTH *line*, a rope passing through a single block on the head of the lower masts to hoist up the rigging, and the persons employed to place the rigging and cross-trees on the mast heads. The girth-line is the first rope employed to rig a ship, after which it is removed till the ship is to be unrigged.

GISEKIA, in botany, so named in honour of Paulus Dietericus Giseke, a genus of the Pentandria Pentagynia class and order. Natural order of Succulentæ. Portulaceæ, Jussieu. Essential character: calyx five-leaved; corolla none; capsule five, approximating, roundish, one-seeded. There is but one species, *viz.* G. pharnacioides, trailing Gisekia, an annual plant, and a native of the East Indies.

GIVEN, among mathematicians and philosophers, the same with data. If a magnitude be known, or we can find another equal to it, it is said to be given in magnitude. Or when the position of any thing is known, it is said to be given in position: when the diameter or radius of a circle is known, the circle is given in magnitude. The circle is given in position, when the position of the centre is given. See DATA.

GLABRARIA, in botany, a genus of the Polyadelphia Polyandria class and order. Essential character: calyx five-cleft; petals five; nectary composed of bristles the length of the calyx; stamens thirty, always in sixes; pericarpium a drupe. There is but one species, *viz.* G. tersa, a large tree resembling the camphor tree, the wood of which is very light and pale coloured, and not being liable to rot or to be injured by insects, it is much used for building both houses and ships. It is a native of the East Indies.

GLACIERS. Those vast piles of eternal ice with which it has pleased the author of nature to crown the immense chasms between the summits of the Alps, objects more grand, sublime, and terrific, than are any others of the phenomena of nature which remain stationary. These tremendous spires and towers of uncertain and brittle fabric, seem to forbid the attempts of travellers to explore the depth between them, or even the rocks and rich vallies around them; but courage and perseverance have been attended with commensurate success, and we are enabled by their labours to learn previously concealed wonders, and to reason upon the causes which produced them. In treating on this subject, it must be remembered, with satisfaction, that great part of our information is derived from the exertions of our own countrymen, ever distinguished for patient investigation and intrepid exploration.

M. Bourrit, Precentor of the Cathedral Church at Geneva, mentions in the relation of his journey to the glaciers of Savoy, the enterprise of Messrs. Windham and Pocock, in 1741, who inspired by the artless relations of the peasants, descriptive of the

sublimity of their country, when they descended with honey and chrystals for sale, determined to visit those frightful regions of ice which had received the appellation of Les Montagnes Maudites, or the accursed mountains; the gentlemen alluded to took every precaution for securing their safety; but entertaining many well-grounded fears, naturally arising from a first attempt, they did not reach any considerable distance beyond the edge of the ice in the valley of Montanvert, yet their example operated so powerfully as to induce several others to imitate them, and proceed to the boundary whence they returned; at length M. de Saussure had the resolution and courage to penetrate across the ice to the very extremities of the vallies; Mr. Coxe followed soon after: and every possible information may be obtained from their publications which the nature of the subject will permit.

The most astonishing phenomenon attending the glaciers, is their near approach to the usual vegetation of summer, for what can be more wonderful than to view wheat ready for the sickle, parched brown by the rays of the sun, separated only by the intervention of a few feet from the chilling influence of an endless bed of ice, which seems impenetrable to its rays.

Many systems and theories have been ingeniously suggested to ascertain the first cause of the glaciers, their maintenance, and whether they increase or diminish in extent, of which Gruner's, improved and illustrated with actual observation by M. de Saussure, is the most rational and probable, and Mr. Coxe implicitly adopts it. Admitting that a person could be raised sufficiently above the summits of the Alps of Switzerland, Savoy, and Dauphine, to comprehend the whole at one view, he would observe a vast chaos of mountains and vallies, with several parallel chains, the highest of which are situated in the centre, and the remainder gradually lessening as they retire from it. The central chain he would find to be surmounted by stupendous fragments of rock, towering in rude masses, which bear vast accumulations of snow and ice where they are not decidedly perpendicular, or do not overhang their bases; on each side he would see the intervening chasms and gulphs, filled with ice, descending thence even into the verdant vallies rich with foliage and cultivation. The inferior ranges of mountains, next the central, present the same appearance in a lesser degree, but in those more remote the snow and ice is confined to the most elevated points; and others, still further removed, are covered with grass and plants, which, in their turn, give place to the hills and vallies common in any part of the world.

Mr. Coxe divides the glaciers in the above general survey into two classes, the first occupy the deep vallies situated in the bosom of the Alps, and the second adhere to the sides and summits of the mountains. Those in the vallies are far more extensive than the upper glaciers, some are several leagues in length, and that of Des Bois is three miles broad and fifteen long; but they do not communicate with each other, and there are few parallel to the central chain; their upper extremities are connected with inaccessible precipices, and the lower proceed as already mentioned, quite into the vales; the depth of these astonishing accumulations of frozen fluid vary from 80 to 600 feet, and they generally rest on an inclined plane; urged forward by their own enormous weight, and but weakly supported by the pointed rocks inserted in their bases, they are universally intersected by yawning chasms of dreadful aspect to the curious investigator, who beholds fanciful representations of walls, towers, and pyramids, on every side of him; but upon reaching those parts were the glacier rests upon an horizontal plane, his progress is seldom impeded by considerable fissures, and he walks in safety over a surface nearly uniform, and not so perfectly polished as that of ponds and rivers suddenly and violently frozen. The absence of transparency, the various marks of air bubbles, and the general roughness, so perfectly resemble the congelation of snow, when half restored to fluidity, that M. de Saussure was immediately led to form the following probable theory of the formation of the glaciers.

Snow is constantly accumulating in the recesses or depths of the mountains, during nine months of the year, by the usual fall of moisture, and the descent of vast masses borne down by their weight from the precipices and crags above. Part of this is necessarily reduced to water by slight thaws and casual rains, and being frozen in this state the glacier is composed of a porous opaque ice.

The upper glaciers, Mr. Coxe subdivides into those which cover the summits, and those which extend along the sides of the Alps; the former originate from the snow

frequently falling and congealing into a firm body, though not becoming actual ice, which the brilliancy of the projections has induced some philosophers to suppose it. M. de Saussure having explored Mont Blanc, ascertained that the top was encrusted with ice, which might be penetrated by a stick, covering a mass of snow on the declivities, so chilled and dry as to be incapable of coherence.

The sides of the Alps support a congelation of half dissolved snow, which is different from the pure snow of the summits and the ice of the lower glaciers. Two causes operate to produce this effect, the first is the descent of water from the higher regions, where a dissolution of the snow sometimes occurs; and the second arises from the more favourable situation of these parts for reflecting the rays of the sun and the consequent melting of the snow. From hence downwards the ice adhering to the cavities becomes gradually more solid by the freezing of the snow-water, then nearly divested of that air which in the less dissolved portions renders the ice, formed from it, porous, opaque, and full of bubbles.

Considerable difference of opinion has prevailed amongst philosophers, whether the masses of ice and snow in these regions of endless winter increase, decrease, or remain nearly stationary; Mr. Coxe seems inclined to think they vary in their size, that gentlemen observes, that the glacier of Montanvert is generally bordered with trees; near the base of this vast body of frozen matter the ice is excavated into an arch, perhaps one hundred feet in height, whence the Arveron rushes with impetuosity and in a large sheet of water. As he approached the ice he passed through a forest of firs, those near the arch were very ancient and about eighty feet high, the trees between them and the glacier were evidently younger from the inferiority of their size and other intrinsic marks, others still less, had been enveloped by the ice, and many were thrown down; arguing from this gradation in the appearance of the firs, he concludes, that the glacier has originally extended to the full grown ancient trees, and dissolving, young ones have grown on its former site, which have been overturned by a fresh increase of ice.

This inference seems almost conclusive, but it is still further supported by the fall of large pieces of granite called moraine by the inhabitants, which, borne along by the ice, sink through it as it dissolves, and falling into the plain, form a border along its extremity; those have been urged forward by the pressure of new ice, and extend even to the place occupied by the large firs.

Exclusive of these circumstances, Mr. Coxe discovered, that the glacier of Grindelwald had diminished, at least, 400 paces between the dates of his two visits in 1776 and 1785; and in the valley of Chamouny, the Muraille de Glace, which he had described as forming the border of the glacier of Bosson, in 1776, no longer existed in 1785, and young trees had grown on the site of the edge of the glacier of Montanvert.

In opposition to the evidence thus adduced, it is argued that the operations observable in the vallies arising from the concentration of solar heat, form no data for judging of those on more elevated situations, where it is asserted a greater quantity of snow falls and becomes ice than can possibly be dissolved annually, and experience proves, beyond doubt, that mountains have been covered, passages obstructed, pastures and habitations destroyed by the ice within the memory of man. In replying to these arguments the result obtained is extremely satisfactory. The rain and sleet falling during summer not only thaws the ice and snow, but forms various channels in it, the water descending must wear and carry along part of the frozen sides and depths, and prepare the way for separating and throwing down large masses of each, which are termed avalanches in some parts of the country, and lauwine in others; those tremendous bodies accumulating by adhesion in their progress, overwhelm every thing in their way, and rush to the vallies from the highest summits, whence various other causes serve to detach them. Here the traveller often meets a dreadful and instantaneous fate; but humanity has endeavoured to obviate it as far as human abilities will permit. Matthison, who visited the monastery of St. Bernard, founded for the relief of those who cross the Alps, speaks thus of the lauwine or avalanche, and the excellent canons of St. Bernard: "In the very worst seasons, as often as it snows, or the weather is foggy, some of these benevolent persons go forth with long poles, and, guided by their excellent dogs, seek the highway, which these sagacious animals never miss, how difficult soever to find. If then the wretched traveller has sunk

beneath the force of the falling lauwine, or is immersed in the snow in a benumbing swoon, how deeply soever he may be buried, the dogs never fail of finding the place of his interment, which they point out by scratching and snuffling, when the sufferer is dug out and carried to the monastery, were every possible exertion is used for his restoration. The number of those who lose their lives in the field of battle is known to all Europe, but no one could give me an account what number have thus had the gift of life conferred on them a second time. Yet notwithstanding all the care and attention of these real friends of mankind, and their faithful dogs, scarcely a year passes, but as the snow melts away in summer, the dead bodies of travellers are discovered, who remote from their homes, and all that was dear to them, have perished here unnoticed and unknown. As the ground for a considerable extent round the monastery is solid rock, the dead bodies are collected together in a chapel, lying on its eastern side, which is made to admit a thorough draft of air, by openings in the walls, guarded by large iron bars. The sight of so many unfortunate persons, probably collected from various parts of the world, yet howsoever remote from each other in life, brought hither by an unfortunate similarity of fate to rest together in death, afflicted my inmost soul. They are all covered with palls, and as in this frozen region no exanimate body moulders, but only gradually shrivels and dries away, so the features remain undisfigured for a considerable length of time, and some have even been recognized by friends and relations, after having lain here for two or three years. The bodies are not disposed one over the other, but are all placed upright, and each fresh corpse leans its head on the breast of the former; this disposition has something familiar in it, and gives them the semblance of being united only in a general slumber. Four rows of these slumberers already rest here, from the faces and hands of many of whom the palls have slipped off and left them uncovered: these have all a perfect mummy-like appearance." The fall of the avalanche necessarily reduces the quantity of snow and frozen fluid on the summits, and the transfer of it to a warmer region, must facilitate its dissolution. The lower glaciers, though not subject to equally precipitate descent, cannot otherwise than gradually advance towards the vallies, which may be inferred from the constant passage of torrents under them, and their own enormous weight; besides the chasms that universally intersect them, plainly evince that their foundations being partially undermined, they glide slowly downward overturning trees, and pushing stones before them; the edges obtruded on the earth by this means naturally dissolve far more rapidly than if they remained stationary.

Another means of dissolution arises from evaporation, which takes place on every portion of the globe, however elevated. Exclusive of the above causes, are the constant play of the beams of the sun on the surfaces of the glaciers, which being capable of redoubled heat by concentration and refraction in some favourable positions, must produce very violent thaws; the air heated by this and similar means in other parts of the mountains, often meets the traveller in streams, which seem as if proceeding from a hot bath, consequently those projections subject to their influence, must vanish rapidly; but a more certain and regular change occurs from the mean temperature of the earth, where the transition from summer heats to winter colds cannot ever take place. "This mean temperature," says Mr. Coxe, "termed by some philosophers the internal heat of the earth, is always above the freezing point, as is evident from the heat of the springs which issue from the bowels of the earth. In winter, therefore, or in those high regions of the globe, where the cold is usually below the freezing point, when any spot of ground is covered with only a thin coat of snow, it may be so far cooled, to a certain depth, by the influence of the external air, as not to be capable of dissolving any part of the superincumbent snow. But when the mass of snow is of such a thickness as to protect the surface of the ground from the effects of the atmospherical cold, the mean temperature which is always above the freezing point will be sufficient to melt the contiguous surface of snow, and to occasion a constant thaw, which supplies those currents of water that flow at all seasons from the upper and lower glaciers."

Having endeavoured to explain the causes of the glaciers and their changes, it will be proper to give an idea of their sublimity in the words of M. Bourrit, who appears to have viewed and described them with all that enthusiasm which such splendid objects must have inspired. "To come at this collected mass of ice (Des Bois) we crossed

the Arve, and travelling in a tolerable road, passed some villages or hamlets, whose inhabitants behaved with much politeness; they invited us to go in and rest ourselves, apologized for our reception, and offered us a taste of their honey. After amusing ourselves some time amongst them, we resumed our road, and entered a beautiful wood of lofty firs, inhabited by squirrels. The bottom is a fine sand, left there by the inundations of the Arveron; it is a very agreeable walk, and exhibits some extraordinary appearances. In proportion as we advanced into this wood, we observed the objects gradually to vanish from our sight; surprised at this circumstance, we were earnest to discover the cause, and our eyes sought in vain for satisfaction, till having passed through it, the charm ceased. Judge of our astonishment, when we saw before us an enormous mass of ice, twenty times as large as the front of our cathedral of St. Peter, and so constructed, that we have only to change our situation to make it resemble whatever we please. It is a magnificent palace, cased over with the purest crystal; a majestic temple, ornamented with a portico, and columns of several shapes and colours; it has the appearance of a fortress, flanked with towers and bastions to the right and left, and at bottom is a grotto, terminating in a dome of bold construction. This fairy dwelling, this enchanted residence or cave of fancy, is the source of the Arveron, and of the gold which is found in the Arve. And if we add to all this rich variety, the ringing tinkling sound of water dropping from its sides, with the glittering refraction of the solar rays, whilst tints of the most lively green, or blue, or yellow, or violet, have the effect of different compartments, in the several divisions of the grotto, the whole is so theatrically splendid, so completely picturesque, so beyond imagination great and beautiful, that I can hardly believe the art of man has ever yet produced, nor ever will produce a building so grand in its construction, or so varied in its ornaments. Desirous of surveying every side of this mass, we crossed the river about four hundred yards from its source, and mounting upon the rocks and ice, approached the vault; but while we were attentively employed in viewing all its parts, astonished at the sportiveness of fancy, we cast our eyes at one considerable member of the pile above us, which was unaccountably supported; it seemed to hold by almost nothing: our imprudence was too evident, and we hastened to retreat; yet scarcely had we stepped back thirty paces before it broke off all at once with a prodigious noise, and tumbled, rolling to the very spot where we were standing just before."

GLACIS, in fortification, that mass of earth which serves as a parapet to the covered way, sloping easily towards the champaign, or field. The glacis, otherwise called esplanade, is about six feet high, and loses itself by an insensible diminution in the space of ten fathoms.

GLADIATORS, persons who fought for the amusement of the public in the arenas of amphitheatres in the city of Rome, and at other places under the dominion of the Romans. The term is derived from their use of the gladius, or sword; and the origin of this horrid custom is said to have been the practice of sacrificing captives to the manes of chiefs killed in battle. It seems, however, more probable, that it arose from the funeral games of antiquity, when the friends of the deceased fought in honour of his memory; an instance of which occurs in the twenty-third book of the Iliad, at the burning of the body of Patroclus, Achilles having ordained every solemn rite usual upon those occasions, Homer adds,

> "The prizes next are ordered to the field,
> For the bold champions who the cæstus wield."

The leather which composed the cæstus being loaded with lead, enabled the combatants to give each other mortal blows, though the hands only were used. Epeus, of gigantic stature, challenged the whole of the Grecian chiefs, who were terrified at his bulk, and Euryalus alone accepted his defiance:

> "Him great Tydides urges to contend,
> Warm with the hopes of conquest for his friend;
> Officious with the cincture girds him round,
> And to his wrist the gloves of death are bound."

The captives slain on this occasion were not commanded to fight; they had been led to the pile, and died with the sheep, oxen, coursers, and dogs, that their bodies might be burnt by the flames which consumed that of Patroclus:

> "Then, last of all, and horrible to tell,
> Sad sacrifice! twelve Trojan captives fell."

The above quotations positively prove, that the Romans deviated from their predecessors in the practice of this barbarous custom. The Greeks appear to have destroyed their prisoners on a revengeful principle, and dispatched them immediately; but the former refined upon cruelty, and would rather purchase captives, or destroy the lives of ill-disposed slaves, than send the ashes of their friends to the urn bloodless, or the spectators of the obsequies home, without the gratification of witnessing wretches cutting each other to death, though not under the influence of previous anger. According to Valerius Maximus, and Lampridius in Heliogabalus, gladiators were first introduced at Rome by M. and D. Brutus, at the funeral of their father, in the consulship of Ap. Claudius and M. Fulvius.

The examples of great men, however detestable, ever produce imitators. Hence, though the brothers may have acted from motives of family vanity only, other great personages, perceiving that the people delighted in the sight of blood, determined to gratify them by adopting the custom; which was afterwards extended to public exhibitions given by the priests in the Ludi Sacerdotales, and the magistrates, solely for the amusement of the populace, or perhaps to confirm them in an habitual contempt for wounds and military death.

Thus the family alluded to, introducing perhaps three pair of gladiators to the citizens of Rome, was the means of multiplying their number to an amount which is shocking to humanity; for the subsequent emperors appear to have attempted to excel each other in assembling them at their birth-day celebrations, at triumphs, the consecration of edifices, at their periodical games, and at the rejoicings after great victories.

As the dispositions of several of the chief magistrates who are recorded as having exhibited gladiators were mild and merciful, it is but fair to suppose, that Julius Cæsar, who produced three hundred and twenty pairs in his edileship, Titus, Trajan, and others, submitted to the custom in compliance with the temper of the people, rather than from any predilection to it in themselves. But there are few pernicious practices which do not carry their punishment with them. The prevailing frenzy had at length arrived to such an excess, that the gladiators became sufficiently numerous to threaten the safety of the state; as when the Catiline conspiracy raged, an order was issued to disperse the gladiators in different garrisons, that they might not join the disaffected party: yet although the fears of the government were excited, it doth not appear that any steps were taken to lessen their number, as the Emperor Otho had it in his power long after the above event to enlist two thousand of them to serve against Vitellius.

The people thus cut off from society, and rendered murderers per force, were fully justified in considering the whole Roman state their enemy; nor was it surprising that they were sometimes willing to revenge themselves upon their oppressors. Spartacus, a gladiator, gave a bold but unavailing example to his brethren, by rushing out of an amphitheatre at Verona, at the head of those collected there for public exhibition, declaring war against the Romans, and assembling so great a force as to make the citizens of Rome tremble. Similar apprehensions were entertained at intervals by enlightened people, and Cicero observed, "The shows of gladiators may possibly to some persons seem barbarous and inhuman: and, indeed, as the case now stands, I cannot say that the censure is unjust. But in those times, when only guilty persons composed the number of combatants, the ear perhaps might receive many better instructions; but it is impossible that any thing which affects our eyes should fortify us with more success against the assaults of grief and death." Still he had the good sense to propose a law prohibiting all candidates for offices from exhibiting gladiators within two years before they became such. Julius Cæsar limited their number in Rome. Augustus ordained that not more than sixty pairs of combatants should fight at one exhibition, and that there should be only two of the latter in a year. During the reign of Tiberius it was decreed, that gladiators were not to be brought before the public by persons worth less than 400,000 sesterces. Constantine the Great had the humanity and courage to abolish the custom, after it had prevailed near six hundred years; but it revived under Constantius Theodosius and Valentinian, and was finally suppressed by the Emperor Honorius.

The guilty persons alluded to by Cicero must apply to those slaves whose masters sold them, for disobedience or mal-practices, to the Lanistæ, who instructing them in the arts of attack and defence, hired them to any rich man disposed to exhibit them.

Had they been entirely confined to this class of people, we might have been less inclined to censure the custom; but when we reflect that honest and courageous soldiers were condemned to undergo the lash of their captors, and afterwards perish by the swords of slaves, or each other, we cannot fail of being astonished that the high-spirited Roman should expose himself to their vengeance, by voluntarily entering the arena with them, there to meet almost certain death. Strange, however, as it appears, freemen fought for hire under the term of auctorati; and even knights, nobles, and senators, who had wasted their property by extravagance, have deigned to become gladiators. Augustus, offended at their conduct, forbid the senatorian order and knights to enter the lists as such; but preceding princes, less influenced by a sense of honour, permitted them to act as they pleased. The contagion, at length, extended to the females of Rome; and, lastly, dwarfs were taught the use of the sword, and fighting with the women, or each other, furnished a new description of diversion. Kennet classes the various sorts of gladiators under the terms of the Retiarii, the Secutores, the Myrmyllones, the Thracians, the Samnites, the Essedarii, and the Andabatæ; the Gladiatores Meridiani fought in the afternoon; the Gladiatores Fiscales were paid from the Emperor's private treasury; the Gladiatores Postulatitii were men of consummate art in their profession; the Gladiatores Catervarii fought in small companies; and the Gladiatores Ordinarii were not particularly distinguished, but fought in a common way.

The dress of the Retiarius was a short habit, and a hat tied under the chin. His means of offence were a weapon called a fuscina, and a net. With the latter in his right hand, he endeavoured to entangle his adversary, and with the fuscina in the left he aimed mortal blows at him; but as this description of gladiator was invariably opposed to a Secutor, armed with a scymeter, a buckler, and a helmet, the Retiarius had no means of escape, if he failed in casting his net, except by flight round the arena, during which he adjusted it for a new trial.

The best gladiators were Thracians. Those men, with their faulchion and small round shields, possessed more national ferocity and cruelty than any of their opponents. Kennet says, "The original of the Samnite gladiators is given by Livy. The Campanians (says he) bearing a great hatred to the Samnites, they armed a part of their gladiators after the fashion of that country, and called them Samnites. They wore a shield broad at the top, to defend the breast and shoulders, and growing more narrow towards the bottom, that it might be moved with the greater convenience. They had a sort of belt coming over their breasts, a greave on their left foot, and a crested helmet on their heads." The Epedarii sometimes engaged from chariots, and at others on foot; and the Andabatæ mounted on horses fought with a helmet which covered their faces and eyes.

The exhibition of gladiators was announced to the public by bills affixed in the public places, sometimes accompanied by paintings of the intended combat, or the most celebrated combatants; and when the time mentioned had arrived, and the people assembled, the gladiators marched slowly round the arena; they were then matched, by persons appointed for that purpose, as equally as possible, and they proceeded to prepare for the contest by fencing with blunted swords, &c.; after which the trumpets were sounded, and the battles began in serious earnest. When a severe wound was given, the gladiator who inflicted it, and the people exclaimed, 'He has it.' If that proved decisive, the vanquished person resigned his weapon, and acknowledged himself conquered. But this submission was not alone sufficient to save his life: the people were to decide his fate. He therefore turned to them, and supplicated for mercy, which was granted, or refused, according to their opinion of his skill and courage. Several learned authors have differed as to the exact manner in which the hands and fingers were placed to express praise or disapprobation on those occasions. According to Juvenal, the bending of the thumbs back authorised the conqueror to kill his adversary as a coward. The Emperor might, however, interfere, if he was present, and save the gladiator; it is supposed, besides, that his entrance at the instant of defeat was favourable to the vanquished party, as far as his life was concerned.

The rewards of the victors consisted of money collected from the spectators; and when they happened to be slaves, they received the pileus, or cap, denoting that from that moment they became free; or the rudis, or wand, which signified their services as gladiators were thenceforth dis-

pensed with, whether slaves or freemen. It was customary for the persons thus situated either to become Lanistæ, or to suspend their arms in the Temple of Hercules.

There are few nations which have not imitated this strange custom, in a greater or less degree, at different periods of their history; and less than a century past we had gladiators in London, who fought and bled, but never killed each other. Malcolm's Anecdotes of the Manners and Customs of this great Metropolis, contains numerous particulars relating to those modern swordsmen, whose exertions were rivalled by several females in the art of boxing and cutting. One of their challenges, from the publication alluded to, will be a proper conclusion to this article. "In Islington Road, on Monday, being the 17th of July, 1727, will be performed a trial of skill by the following combatants: We, Robert Barker and Mary Welsh, from Ireland, having often *contaminated* our swords in the *abdomnious corporations* of such antagonists as have had the insolence to dispute our skill, do find ourselves once more necessitated to challenge, defy, and invite Mr. Stokes, and his bold Amazonian virago, to meet us on the stage; where we hope to give a satisfaction to the honourable lord of our nation, who has laid a wager of twenty guineas on our heads. They that give the most cuts to have the whole money, and the benefit of the house. And if swords, daggers, quarter-staff, fury, rage, and resolution will prevail, our friends shall not meet with a disappointment."—"We, James and Elizabeth Stokes, of the city of London, having already gained an universal approbation by our agility of body, dextrous hands, and courageous hearts, need not *preambulate* on this occasion, but rather choose to exercise the sword to their sorrow, and corroborate the general opinion of the town, than to follow the custom of our repartee antagonists. This will be the last time of Mrs. Stokes performing on the stage. There will be a door on purpose for the reception of the gentlemen, where coaches may drive up to it, and the company come in without being crowded. Attendance will be given at three, and the combatants mount at six. They all fight in the same dresses as before."

GLADIOLUS, in botany, English *corn-flag*, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla six-parted, irregular, unequal; stigmas three. There are thirty species: these are herbaceous, perennial plants, with a tuberous-coated root; a simple stalk; the flowers specious, in spikes, with a spathe to each flower.

GLAMA, a species of Peruvian camel, with the back even, and the breast gibbose. See CAMELUS.

GLANCE, in mineralogy, one of the ores of cobalt, found in beds of mica, in Sweden: its colour is tin-white; it is massive in various forms, and crystallized in cubes and octahedrons; the surface of the crystals is smooth and splendent; it is brittle, and the specific gravity is 6.45.

GLAND, in anatomy, a small body, formed by the interweaving of vessels of every kind, covered with a membrane, usually provided with an excretory duct, and destined to separate some particular fluid from the mass of blood, or to perfect the lymph. See ANATOMY and PHYSIOLOGY.

The glands have been chemically examined by Fourcroy and others. There are two sets of them: the conglobate, which are small, scattered in the course of the lymphatics; and the conglomerate, such as the liver, kidneys, &c. Fourcroy supposes the first to be composed of gelatine; the composition of the others has not been ascertained.

GLANDERS. See FARRIERY.

GLANS. See ANATOMY.

GLAREOLA, the *pratincolé*, in natural history, a genus of birds of the order Grallæ. Generic character: bill strong, strait, short, hooked at the end; nostrils at the base, linear and oblique; feet four-toed; toes long, slender, connected at the base by a membrane; tail forked, consisting of twelve feathers. There are three species, of which the principal is P. austriaca; this is about as large as a black-bird, lives on water-insects and on worms; is found in great numbers on the banks of the Rhine, in the neighbourhood of Strasburgh, and in innumerable flocks in the deserts of the Caspian Sea; it is a bird particularly clamorous and restless. See Aves, Plate VII. fig. 5.

GLASS, a substance too well known to admit of a definition. It is a compound of the fixed alkalies, or alkaline earths with silica, brought into complete fusion, and then suddenly congealed. Silica, when

mixed with the fixed alkalies, and exposed to a strong heat, readily enters into fusion. In this state the mixture may be moulded into any shape, and if suddenly cooled below the temperature at which it assumes the solid state, it retains the transparency, and those peculiar properties that belong to the substance called glass. Metallic oxides are sometimes added, as well to assist in the fusion, as to communicate certain colours to the mass. If the melted glass be suffered to cool very slowly, the different tendency of the constituent part to assume solid forms at certain temperatures, will cause them to separate successively in crystals, as salts held in solution in water assume the form of crystals as the liquid is slowly evaporated. But if the glass be suddenly cooled down to the point of congelation, the constituents have not time to separate in succession, and the glass remains the same homogeneous compound as while in a state of fusion. Hence it should seem that the vitreous quality depends entirely 1. upon the fusibility of the mixture; and, 2. on the suddenness with which it is cooled down to the point of congelation. It was discovered by Sir James Hall, that glass always loses its vitreous state, and assumes that of a stone, if more than a minute or two elapses while it is cooling down from complete fusion to the point at which it congeals.

There are several kinds of glass adapted to different uses. The best and most beautiful are the flint and the plate glass. These when well made, are perfectly transparent and colourless, heavy and brilliant. They are composed of fixed alkali, pure siliceous sand, calcined flints, and litharge in different proportions. The flint glass contain a large quantity of oxide of lead, which by certain processes is easily separated. The plate glass is poured in the melted state upon a table covered with copper. The plate is cast half an inch thick, or more, and is ground down to a proper degree of thinness, and then polished.

Crown-glass, that used for windows, is made without lead, chiefly of fixed alkali fused with siliceous sand, to which is added some black oxide of manganese, which is apt to give the glass a tinge of purple.

Bottle-glass is the coarsest and cheapest kind: into this little or no fixed alkali enters the composition. It consists of an alkaline earth combined with alumina and silica. In this country it is composed of sand and the refuse of the soap-boiler, which consists of the lime employed in rendering his alkali caustic, and of the earthy matters with which the alkali was contaminated. The most fusible is flint-glass, and the least fusible is bottle-glass.

Flint-glass melts at the temperature of 10° Wedgewood; crown-glass at 30°; and bottle-glass at 47°. The specific gravity varies between 2.48 and 3.33.

Good glass is perfectly transparent, and when cold very brittle, but at a red heat it is one of the most ductile bodies known, and may be drawn into threads so very delicate, as to become almost invisible to the human eye. It is extremely elastic, and one of the most sonorous of bodies. See Harmonica.

There are but few chemical agents which have any action upon it. Mr. Davy in one of his lectures delivered in the course of the present month, (May, 1808,) exhibited a method of decomposing it by means of the Voltaic battery: he, however, first reduced it to powder. Fluoric acid, as we have seen, has a great power over it, and dissolves it very quickly (see Fluoric Acid); so also have the fixed alkalies when assisted by heat. The continued action of hot water is said to be capable of decomposing glass, which it is thought will fully explain how the siliceous earth was obtained by Boyle and others, when they subjected water to very tedious distillations in glass vessels. It has also been supposed, that the deflagration of the oxygen and hydrogen gases, in the formation of water, has decomposed the glass, which will account for an acid as part of the result.

In making glass, the materials are completely fused together, and in this state the hot mixture is called frit. The frit is introduced into large pots made of prepared clay, and exposed to a heat sufficient to melt it completely. When the fusion has continued the proper time, the furnace is allowed to cool a little. In this state the glass is exceedingly ductile, and will assume any shape according to the fancy of the workman. The vessels thus formed, must not be permitted to cool too quickly, hence they are put into a hot furnace, in order that the heat may pass off very gradually: this is called annealing.

Glass is often tinged of various colours, which is performed by mixing with it, while in fusion, some one of the metallic oxides. Thus blue glass is formed by the oxide of cobalt; green by the oxide of iron, or copper; violet by the oxide of manganese;

red by a mixture of the oxides of copper and iron; purple by the oxide of gold; white by the oxide of arsenic and zinc; and yellow by the oxide of silver, and by combustible bodies.

We shall give now a detail of the manual operations in the manufacture of glass.

Glass-blowing, the art of forming vessels of glass; the term, however, is exclusively applied to those vessels which are blown by the mouth. The operation is exceedingly simple, the workman has a tube of iron, the end of which he dips into a pot of melted glass, and thus gathers a small quantity of glass on the end of it, he then applies the other end of the tube to his mouth and blows air through it, this air enters into the body of the fluid glass, and expands it out into a hollow globe, similar to the soap bladders blown from a tobacco pipe. Various methods are used to bring these hollow globes into forms of the different utensils in common domestic use, and several tools; the chief part of these are represented in PLATE-GLASS MAKING.

The first and greatest of the glass-blowers' implements is the furnace; it consists of two large domes set one over the other, the lower one stands over a long grating, (on a level with the ground,) on which the fuel is placed; beneath the grate is the ash pit, and a large arch leading to it, conveys air to the furnace. In the sides of the lower dome, as many holes or mouths are made as there are workmen to make use of the furnace, and before each mouth a pot of melted glass is placed; the pots are very large like crucibles, and will hold from three to four hundred weight of liquid glass, they are supported upon three small piers of brickwork, resting on the floor of the furnace. The form reverberates the flame from the roof down upon the pots, and they are placed at some distance within the furnace, that the flame may get between the wall and the pots. The upper dome is built upon the other, and its floor made flat by filling up round the roof of the lower dome with brickwork, there is a small chimney opens from the top of the lower dome into the middle of the floor of the upper one, which conveys the smoke away from it, and a flue from the upper dome leads it completely from the furnace.

The upper dome is used for annealing the glass, and is exactly similar to a large oven, it has three mouths, and in different parts a small flight of steps leads up to each. We now come to describe the smaller implements.

Fig. 1 and 2, is a bench or stool with two arms *a b* at its ends, which are a little inclined to the horizon; the operator when at work sits upon the stool, and lays his blowing tube *d* across the arms, as shewn in the figure.

Fig. 3, are a pair of shears, or rather plyers, formed of one piece of steel, they have no sharp edges, and spring open when permitted; the workmen has several of these of different sizes, which are hung upon hooks at *e* in the stool fig. 4.

Fig. 4, is a pair of compasses to measure the work, and ascertain when it is brought to the proper size, the workmen should have three or four of these.

Fig. 5, a common pair of shears for cutting the soft glass.

Fig. 6, a very coarse flat file.

Fig. 7, is the blowing pipe; it is simply a wrought iron tube about three feet long, at *x*, it is covered with twine to prevent it burning the workman's hand.

Fig. 8, a small iron rod, of which there should be several.

Fig. 9, is a stool with a flat plate of cast iron laid upon it, and *f* is another flat plate upon the ground behind the stool.

To explain the use of these tools, we shall describe the manner of forming a lamp or urn of glass. Fig. 10, with a wide mouth at top and a small neck *g* at bottom, through which the candle is inserted, and which is fitted into a brass cap to support the lamp by.

The operation is conducted by three workmen. The first takes the blowing pipe 7, and after heating it to a red heat at the mouth of the furnace, dips it into the pot of melted glass, at the same time turning it round that it may take up the glass, which has then much the consistence of turpentine; in the quantity of metal he is guided by experience, and must proportion it to the size of the vessel to be blown, he then brings it from the furnace to the stool, fig. 9, and rolls the lump of glass upon it to bring it to a round form, after which he blows through the pipe, resting the glass upon the iron plate *f* behind the stool, as in the figure, and rolling it backwards and forwards. The blowing makes the glass hollow, and he has several methods of bringing it to a proper shape to be worked; by simply blowing, it would assume a figure nearly globular, if he wants

it any bigger, in the equatrial diameter *g g*, fig. 11, he lays the pipe on a hook driven in the side of the stool, and turns it round very quickly, the centrifugal force soon enlarges it in the equator. If on the other hand he wishes to lengthen its polar diameter, he holds the pipe perpendicular, the glass hanging downwards, its weight lengthening it, and to shorten the polar diameter he holds the pipe upright, the glass at the top; by blowing through the pipe the capacity is increased, and the thickness of the glass of the vessel diminished.

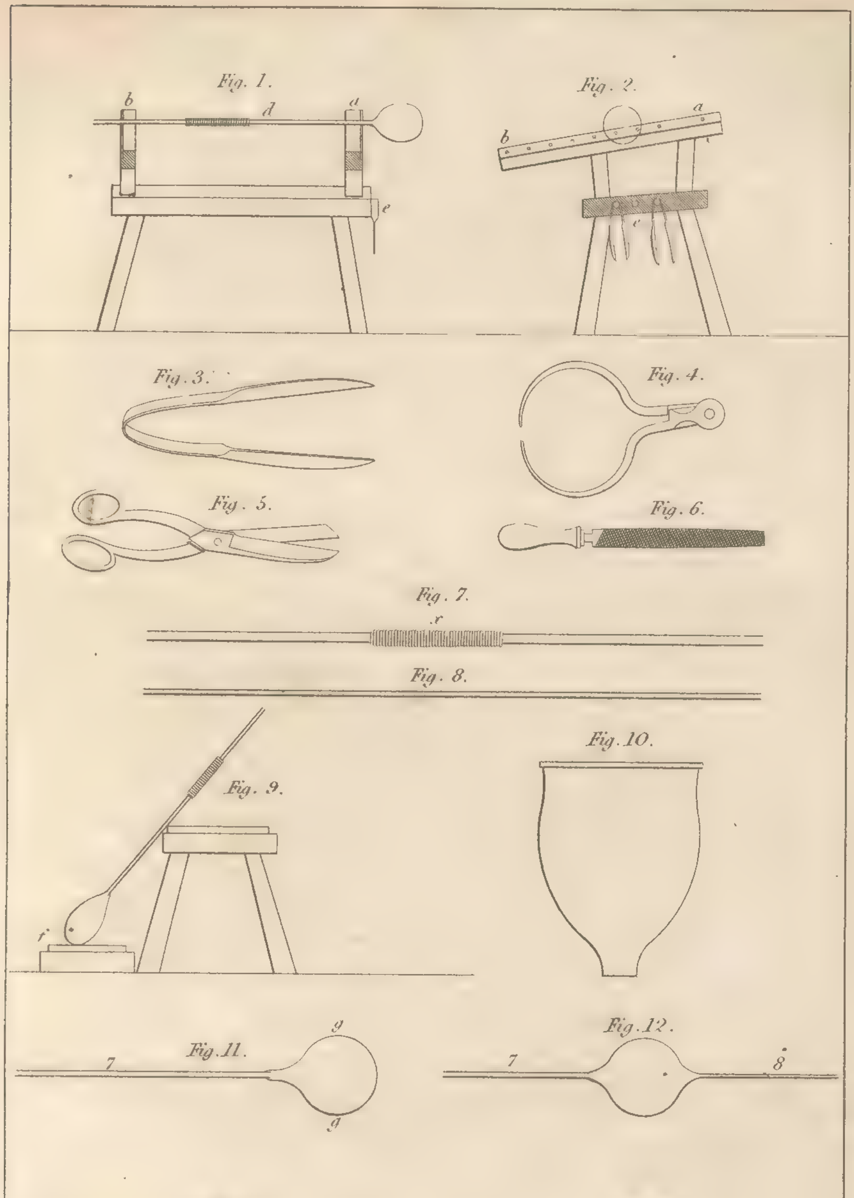
We now suppose that by a very dexterous application of the above methods, the workmen has brought it to the shape of fig. 11, he now carries it to the mouth of the furnace, and holds it in to get a fresh heat, (for by this time it is become too stiff to work easily,) taking care to turn it round slowly, that it may not alter its figure. The vessels in this stage is delivered to the second, or principal workman, the other two being only assistants, he is seated upon the stool, figs. 1 and 2, and lays the blowing pipe with the glass at its end across its arm *a b*, and with his left hand rolls the pipe along the arms, turning the glass and pipe round at the same time; in his right hand he holds the pliers, fig. 3, whose blades are rubbed over with a small piece of bees-wax, and as the glass turns round presses the blade of the shears against it, following it with the shears as it rolls, at the end or side as occasion requires, until he has brought it to the proper size which he determines by the compasses, fig. 4, though not materially altering its figure, the first workman kneeling on the ground and blowing with his mouth at the end of the pipe, which hangs over the arm *b* when directed by his principal. The third workman now produces the small rod, fig. 8, which is dipped into the melting pot to take up a small piece of metal to serve as cement, the end of this rod he applies to the centre of the glass just opposite the blowing pipe, the principal workman directing it, by holding its end between his pliers, the rod by the small piece of glass on its end immediately sticks to the glass vessel, and the third workman draws it away, both workmen turning their rods round, but in contrary directions; this operation forms a short tube on the end, as in fig. 12. The principal workman then takes the short tube at *i*, between the blades of a pair of pliers, exactly like the others, but which are not covered with bees-wax, the cold of these pliers, instantly cracks the glass all round, and a very slight jerk struck upon the rod 8, breaks it off. A hole is now made in the end of the glass, which is enlarged by the pliers while the glass is turned, as in fig. 13, until the neck is brought to the proper size and length to fit the brass cap as before described, and the inferior half of the lamp is brought to its shape and size in the same manner.

In order to form the upper half, the third workman has in the mean time being preparing a round lump of glass K, fig. 14, on the end of one of the rods fig. 8, this he applies hot to the end of the neck, it being guided by the principal workman, and it immediately holds tight, he then breaks off the other neck at 7, by the cold pliers, and thus separates it from the blowing pipe.

The glass is now heated a third time, and brought from the furnace in the state, fig. 15, to the principal workman, who enlarges the small orifice at the end by turning it round, and holding the pliers against it, until he enlarges it, as in fig. 16, to the shape of fig. 10, it is now finished, and the third workman takes it to a stool strewed over with small coals, he rests the rod upon the edge of the stool, and with the file, fig. 6, files the joint at the bottom neck and soon breaks off, and the lamp falls upon the coals, the distance being so very small, as to be in no danger of breaking; a boy now puts the end of a long stick into the open mouth of the glass, and thus carries it up the steps before described, places it in the annealling oven, where it remains some hours, when taken out it must be cooled gradually, and is fit for sale.

In the history of glass there is a fact deserving record; it is related by Pliny, that the discovery was owing to the following accident. Some merchants with soda as part of their freight, had cast anchor at the mouth of the river Belus, in Phœnicia, and were dressing their dinner on the sand, making use of large lumps of the soda as supports for their kettles. The heat of the fire melted the soda, and the siliceous earth together; the result was glass. The hint was not lost, and a manufacture in that trading country was instantly established, and to this place it was for a long time confined. Glass was undoubtedly made in great perfection among the ancients. In their accounts we read of drinking glasses, glass prisms, and coloured glasses of various kinds. Glass was first used for windows in the third

IMPLEMENTS used in GLASS BLOWING.



J. Farey Jun.r delin. Lowry sculp.

London. Published by Longman Hurst, Rees & Orme Aug.st 1. 1808.

century of the Christian æra, but it did not come into common use till very long after this.

Glass, *painting on.* See Enamelling.

Glass, in sea affairs, the usual appellation for a telescope. A night-glass is a telescope made for viewing objects at night. Half-hour glass, called also the watch-glass, is used to measure the time which each watch has to stay upon deck. Half and quarter-minute glasses are used to ascertain the rate of the ship's velocity, measured by the log; these glasses should be frequently compared with a good stop-watch, to determine exactly how many seconds they run.

GLAUBER (John Rudolph), an industrious chemist, was born in Germany. After passing a considerable time in travel, he settled at Amsterdam, about the middle of the seventeenth century. He wrote a number of works, mostly infected with the enigmatical jargon and unintelligible theory of the hermetic philosophy, yet containing some useful facts in true chemistry, and some processes of his own invention. His name is perpetuated in the purgative neutral salt called Glauber's, composed of the sulphurc acid and soda; a valuable remedy, but, together with others of his invention, extolled by himself to an extravagant degree. He kept several of his medicines secret, and made advantage of them as nostrums. Of his works an abridged collection was made in German, which was translated into English in 1689; but they are now consigned to oblivion.

Glauber's *salt.* See Soda, *sulphate of.* It is found native; and, according to Bergman, it contains sulphuric acid, soda, and water, in the proportions of 27.15.58; that is, when saturated with water of crystallization. When efflorescent, the native Glauber's salt contains, beside pure sulphate of soda, some oxide of iron, and portions of muriate and carbonate of soda. It is found in old salt-mines, on the borders of the salt lakes in different parts of the world, and on the surface of peat-mosses in France. It is also held in solution in the Natron-lakes of Egypt, and the mineral springs of Carlsbad. Glauber's salt easily dissolves in water, and shoots into long and beautiful crystals, which contain a large quantity of water; in consequence of which they undergo the aqueous fusion, when exposed to heat. This salt, on account of its efficacy as a purgative, was formerly held in the highest esteem, and was denominated sal mirabile Glauberi. It has been used in some countries as a substitute for soda, in the manufacture of white glass.

GLAUCOPIS, or the *wattle-bird,* in natural history, a genus of birds of the order Picæ. Generic character: bill incurvate and arched; lower mandible shorter than the upper, and carunculate beneath at the base; nostrils depressed, half covered with a cartilaginous membrane; tongue cartilaginous, split and ciliated at the end; legs carinated at the back; feet formed for walking.

The G. cinerea, or cinereous wattle-bird, is about the size of a jay; it is found in every part of New Zealand: berries, and insects of almost every kind, constitute its food; it rarely perches on trees; but is often seen walking on the ground; its notes are said at different times to resemble whistlings and murmurings, and its flesh is good for the table.

GLAUX, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Calycanthemæ. Salicariæ, Jussieu. Essential character: calyx one-leafed, bell-shaped; corolla none; capsule one-celled, five-valved, five-seeded. There is only one species, *viz.* G. maritima, sea milkwort, or black salt-wort. It is common on the sea-coast, and on salt marshes at a distance from the sea; it is a beautiful little plant, enlivening large tracts of the dreary situations where it is found; the whole plant is succulent, and salt to the taste.

GLAZING, in the arts, is the polishing or crusting over earthen ware. When earthen ware is properly baked, it is dipped into a composition called a glaze, made by mixing together in water, till it becomes as thick as cream; fifty-six parts of white lead, twelve of ground flints, and three of ground flint glass. The ware, by being baked, acquires a strong property of imbibing moisture, and in this state, it is called biscuit; when dipped into the glaze, it attracts it into its pores, and the ware becomes presently dry; it is then exposed a second time to the fire, by which means the glaze it has imbibed is melted, and a thin, glassy coat is formed upon the surface. The colour is more or less yellow, according as a greater or less proportion of lead has been used. The lead promotes also the vitrification; the flint serves to give a consistency to the lead during the time of its vitrification, and to prevent its becoming too fluid, and running down the sides of the ware, and thereby leaving them unglazed. This kind of glazing by lead, is

liable to be attacked by acids, and of acting in some degree as a poison; a substitute has therefore been recommended, which consists of equal parts of white glass and soda finely pulverized, and exposed to a strong heat till quite dry, and with this the vessels are varnished or glazed. See POTTERY.

GLEANING, in law. It hath been said, that by the common law and custom of England, the poor are allowed to enter and glean upon another's ground, after the harvest, without being guilty of trespass; and that this humane provision seems borrowed from the Mosaical law; but it is now positively settled, by a solemn judgment of the court of Common Pleas, that a right to glean in the harvest field cannot be claimed as a general right by every person at common law; nor as a custom by the poor of a parish, legally settled.

GLEBE, or *Glebe-land*, is a portion of land, meadow or pasture, belonging to, or parcel of the parsonage or vicarage, over and above the tithes.

Glebe lands, in the hands of the parson, shall not pay tithes to the vicar; nor, being in the hands of the vicar, shall they pay tithes to the parson. By statute 28 Henry VIII. c. 11, every successor, on a month's warning after induction, shall have the mansion-house, and the glebe belonging thereto, not sown at the time of the predecessor's death. He that is instituted, may enter into the glebe-land before induction, and has right to have it against any strangers.

GLECHOMA, in botany, English *ground-ivy*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx five cleft; each pair of anthers converging in form of a cross. There is but one species, *viz.* G. hederacea, ground-ivy.

GLEDITSIA, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: hermaphrodite; calyx four-cleft; corolla four-petalled; stamens six; pistil one, legume. There is only one species, with several varieties.

GLEE, in music, a vocal composition in three or more parts, generally consisting of more than one movement, the subject of which may be either gay, tender, or grave; bachanalian, amatory, or pathetic.

GLEET, in medicine, the flux of a thin, limpid humour from the urethra.

GLINUS, in botany, a genus of the Dodecandria Pentagynia class and order. Natural order of Coryophyllei. Ficoideæ, Jussieu. Essential character: calyx five-leaved; corolla none; nectaries cloven-bristles; capsule five-cornered, five-celled, five-valved, containing numerous seeds. There are three species.

GLOBBA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character: calyx superior, trifid; corolla equal, trifid; capsule three-celled; seeds very many. There are four species.

GLOBE, a round or spherical body, more usually called a sphere, bounded by one uniform convex surface, every point of which is equally distant from a point within called its centre. Euclid defines the globe or sphere, to be a solid figure described by the revolution of a semi-circle about its diameter, which remains unmoved. Also, its axis is the fixed line or diameter about which the semi-circle revolves; and its centre is the same with that of the revolving semi-circle, a diameter of it being any right line that passes through the centre, and terminated both ways by the superficies of the sphere.

Euclid, at the end of the twelfth book, shews that spheres are to one another in the triplicate ratio of their diameters, that is, their solidities are to one another as the cubes of their diameters. And Archimedes determines the real magnitudes and measures of the surfaces and solidities of spheres and their segments, in his treatise "De Sphæra et Cylindro:" *viz.* 1. That the superfices of any globe is equal to four times a great circle of it. 2. That any sphere is equal to two-thirds of its circumscribing cylinder, or of the cylinder of the same diameter and altitude. 3. That the curve surface of the segment of a globe, is equal to the circle whose radius is the line drawn from the vertex of the segment to the circumference of the base. 4. That the content of a solid sector of the globe, is equal to a cone whose altitude is the radius of the globe, and its base equal to the curve superficies or the base of the sector, with many other properties. And from hence are easily deduced these practical rules for the surfaces and solidities of globes and their segments; *viz.* 1. "For the Surface of a Globe," multiply the square of the diameter by 3.1416; or multiply the diameter by the circumference. 2. "For the Soli-

dity of a Globe," multiply the cube of the diameter by .5236 (*viz.* one-sixth of 3.1416); or multiply the surface by one-sixth of the diameter. 3. "For the Surface of a Segment," multiply the diameter of the globe by the altitude of the segment and the product again by 3.1416. 4. "For the Solidity of a Segment," multiply the square of the diameter of the globe by the difference between three times that diameter and twice the altitude of the segment, and the product again by .5236, or one-sixth of 3.1416.

Hence, if d denote the diameter of the globe,

c the circumference,
a the altitude of any segment, and
$p = 3.1416$; then

	The surface.	The solidity.
In the globe	$pd^2 = cd$	$\frac{1}{6}pd^3$
In the segment	pad	$\frac{1}{6}pd^2 \times \overline{3d - 2a}.$

See Mensuration.

Globe, in practical mathematics, an artificial spherical body, on the convex surface of which are represented the countries, seas, &c. of our earth; or the face of the heavens, the circles of the sphere, &c. That with the parts of the earth delineated upon its surface, is called the terrestrial globe; and that with the constellations, &c. the celestial globe. These globes are placed in frames, with other appurtenances. Their principal use, besides serving as maps to distinguish the outward parts of the earth, and the situation of the fixed stars, is to illustrate and explain the phenomena arising from the diurnal motion of the earth.

The globes commonly used are composed of plaster and paper in the following manner: A wooden axis is provided, somewhat less than the intended diameter of the globe, and into the extremes two iron wires are driven for poles: this axis is to be the beam or basis of the whole structure. On the axis are applied two spherical or rather hemispherical caps, formed on a kind of wooden mould or block. These caps consist of pasteboard or paper, laid one lay after another on the mould, to the thickness of a crown-piece; after which, having stood to dry and embody, making an incision along the middle, the two caps thus parted are slipped off the mould. They remain now to be applied on the poles of the axis, as before they were on those of the mould; and to fix them in their new place, the two edges are sewed together with packthread, &c. The rudiments of the globe thus laid, they proceed to strengthen and make it smooth and regular. In order to this, the two poles are hasped in a metalline semicircle of the size intended; and a kind of plaster made of whiting, water, and glue, heated, melted, and incorporated together, is daubed all over the paper surface. In proportion as the plaster is applied, the ball is turned round in the semicircle, the edge of which pares off whatever is superfluous, and beyond the due dimension, leaving the rest adhering in places that are short of it. After such application of plaster, the ball stands to dry; which done it is put again in the semicircle, and fresh matter applied: thus they continue alternately to apply the composition, and dry it, till the ball every where accurately touches the semicircle; in which state it is perfectly smooth, regular, and complete. The ball thus finished, it remains to paste the map or description on it. In order to this, the map is projected in several gores or gussets, all which join accurately on the spherical surface, and cover the whole ball. To direct the application of these gores, lines are drawn by a semicircle on the surface of the ball, dividing it into a number of equal parts corresponding to those of the gores, and subdividing those again answerably to the lines and divisions of the gores.

The papers thus pasted on, there remains nothing but to colour and illuminate the globe, and to varnish it, the better to resist dust, moisture, &c. The globe itself thus finished, they hang it in a brass meridian, with an hour-circle and a quadrant of altitude, and thus fit it into a wooden horizon.

There are ten principal circles represented upon globes, *viz.* six greater and four lesser ones. The greater circles are the horizon, meridian, and equinoctial, as it is called on the celestial, and equator on the terrestrial globe, the ecliptic drawn along the middle of the zodiac, and the two colures.

The lesser circles, of principal use, are the two tropics and two polar circles.

Of these circles some are fixed, and always obtain the same position; others moveable, according to the position of the observer. The fixed circles are the equator and ecliptic, with their parallels and secondaries; which are usually delineated upon the surface of the globes. The moveable

circles are the horizon, with its parallels and secondaries.

The horizon is that broad wooden circle surrounding the globe, and dividing it into two equal parts, called the upper and lower hemispheres. It has two notches, to let the brazen meridian slip up and down, according to the different heights of the pole. On the flat side of this circle are described the twelve signs, the months of the year, the points of the compass, &c. The brazen meridian is an annulus or ring of brass, divided into degrees, *viz.* each quadrant in 90 degrees. It divides the globe into two equal parts, called the eastern and western hemispheres. The quadrant of altitude is a thin pliable plate of brass, answering exactly to a quadrant of the meridian. It is divided into 90°, and has a notch, nut, and screw, to fix to the brazen meridian in the zenith of any place; where it turns round a pivot, and supplies the room of verticle circles. The hour-circle is a flat ring of brass, divided into twenty-four equal parts, or hour-distances; and on the pole of the globe is fixed an index, that turns round with the globe, and points out the hours upon the hour-circle. Lastly, there is generally added a compass and needle upon the pediment of the frame.

The surface of the celestial globe may be esteemed a just representation of the concave expanse of the heavens, notwithstanding its convexity; for it is easy to conceive the eye placed in the centre of the globe, and viewing the stars on its surface; supposing it made of glass, as some globes are: also that if holes were made in the centre of each star, the eye in the centre of the globe, properly placed, would view through each of the holes the very stars in the heavens represented by them.

As it would be impossible to have any distinct notion of the stars, in respect of their number, order, and distances, without arranging them in certain forms, called constellations, this the first observers of the heavens took care to do; and these, like kingdoms and countries upon the terrestrial globe, serve to distinguish the different parts of the superficies of the celestial globe.

The stars, therefore, are all disposed in constellations under the forms of various animals, whose names and figures are represented on the celestial globe; which were first invented by the ancient astronomers and poets, and are still retained for the better distinction of these luminaries. We shall now give some problems on both the globes, beginning with the terrestrial globe.

TERRESTRIAL GLOBE.

Prob. 1. "To find the latitude and longitude of any place." Bring the place to the graduated side of the first meridian: then the degree of the meridian it cuts is the latitude sought; and the degree of the equator then under the meridian is the longitude.

2. "To find a place, having a given latitude and longitude." Find the degree of longitude on the equator, and bring it to the brass meridian; then find the degree of latitude on the meridian, either north or south of the equator, as the given latitude is north or south; and the point of the globe just under that degree of latitude is the place required.

3. "To find all the places on the globe that have the same latitude, and the same longitude, or hour, with a given place, as suppose London." Bring the given place, London, to the meridian, and observe what places are just under the edge of it, from north to south; and all those places have the same longitude and hour with it. Then turn the globe round; and all those places which pass just under the given degree of latitude on the meridian, have the same latitude with the given place.

4. "To find the antœci, periœci and antipodes, of any given place, suppose London." Bring the given place, London, to the meridian, then count 51½ the same degree of latitude southward, or towards the other pole, and the point thus arrived at will be the antœci, or where the hour of the day or night is always the same at both places at the same time, and where the seasons and lengths of days and nights are also equal, but at half a year distance from each other, because their seasons are opposite or contrary. London being still under the meridian, set the hour index to twelve at noon, or pointing towards London; then turn the globe just half round, or till the index point to the opposite hour, or twelve at night; and the place that comes under the same degree of the meridian where London was, shews where the periœci dwell, or those people that have the same seasons and at the same time as London, as also the same length of days and nights, &c. at that time, but only their time or hour is just opposite, or twelve hours distant, being day with one when

night with the other, &c. Lastly, as the globe stands, count down by the meridian the same degree of latitude south, and that will give the place of the antipodes of London, being diametrically under or opposite to it; and so having all its times, both hours and seasons opposite, being day with the one when night with the other, and summer with the one when winter with the other.

5. " To find the distance of two places on the globe." If the two places be either both on the equator, or both on the same meridian, the number of degrees in the distance between them, reduced into miles, at the rate of seventy English miles to the degree, (or more exact sixty-nine and one-fifth), will give the distance nearly. But in any other situations of the two places, lay the quadrant of altitude over them, and the degrees counted upon it, from the one place to the other, and turned into miles as above, will give the distance in this case.

6. " To find the difference in the time of the day at any two given places, and thence the difference of longitude." Bring one of the places to the meridian, and set the hour index to twelve at noon; then turn the globe till the other place comes to the meridian, and the index will point out the difference of time; then by allowing fifteen degrees to every hour, or one degree to four minutes of time, the difference of longitude will be known. Or the difference of longitude may be found without the time, thus:

First bring the one place to the meridian, and note the degree of longitude on the equator cut by it; then do the same by the other place; which gives the longitudes of the two places; then subtracting the one number of degrees from the other, gives the difference of longitude sought.

7. " The time being known at any given place, as suppose London, to find what hour it is in any other part of the world." Bring the given place, London, to the meridian, and set the index to the given hour; then turn the globe till the other place come to the meridian, and look at what hour the index points, which will be the time sought.

8. " To find the sun's place in the ecliptic, and also on the globe, at any given time." Look into the calendar on the wooden horizon for the month and day of the month proposed, and immediately opposite stands the sign and degree which the sun is in on that day. Then in the ecliptic drawn upon the globe, look for the same sign and degree, and that will be the place of the sun required.

9. " To find at what place on the earth the sun is vertical, at a given moment of time at another place, as suppose London." Find the sun's place on the globe by the last problem, and turn the globe about till that place come to the meridian, and note the degree of the meridian just over it. Then turn the globe till the given place, London, come to the meridian, and set the index to the given moment of time. Lastly, turn the globe till the index points to twelve at noon; then the place of the earth, or globe, which stands under the before noted degree, has the sun at that moment in the zenith.

10. " To find how long the sun shines without setting, in any given place in the frigid zones." Subtract the degrees of latitude of the given place from ninety, which gives the complement of the latitude, and count the number of this complement upon the meridian from the equator towards the pole, marking that point of the meridian; then turn the globe round, and carefully observe what two degrees of the ecliptic pass exactly under the point marked on the meridian. Then look for the same degrees of the ecliptic on the wooden horizon, and just opposite to them stand the months and days of the months corresponding, and between which two days the sun never sets in that latitude.

If the beginning and end of the longest night be required, or the period of time in which the sun never rises at that place; count the same complement of latitude towards the south or farthest pole, and then the rest of the work will be the same in all respects as above.

Note, that this solution is independent of the horizontal refraction of the sun, which raises him rather more than half a degree higher, by that means making the day so much longer, and the night the shorter; therefore in this case, set the mark on the meridian half a degree higher up towards the north pole, than what the complement of latitude gives; then proceed with it as before, and the more exact time and length of the longest day and night will be found.

11. " A place being given in the torrid zone, to find on what two days of the year the sun is vertical at that place." Turn the globe about till the given place come to the meridian, and note the degree of the meridian it comes under. Next turn the

globe round again, and note the two points of the ecliptic passing under that degree of the meridian. Lastly, by the wooden horizon, find on what days the sun is in those two points of the ecliptic; and on these days he will be vertical to the given place.

12. "To find those places in the torrid zone to which the sun is vertical on a given day." Having found the sun's place in the ecliptic, as in the eighth problem, turn the globe to bring the same point of the ecliptic on the globe to the meridian; then again turn the globe round, and note all the places which pass under that point of the meridian; which will be the places sought.

After the same manner may be found what people are ascii for any given day. And also to what place of the earth, the moon, or any other planet, is vertical on a given day; finding the place of the planet on the globe by means of its right ascension and declination, like finding a place from its longitude and latitude given.

13. "To rectify the globe for the latitude of any place. By sliding the brass meridian in its groove, elevate the pole as far above the horizon as is equal to the latitude of the place; so for London, raise the north pole fifty-one and a half degrees above the wooden horizon: then turn the globe on its axis till the place, as London, come to the meridian, and there set the index to twelve at noon. Then is the place exactly on the vertex, or top point of the globe, at ninety degrees every way round from the wooden horizon, which represents the horizon of the place. And if the frame of the globe be turned about till the compass needle point to twenty-two and a half degrees, or two points west of the north point (because the variation of the magnetic needle is nearly twenty-two and a half degrees west), so shall the globe then stand in the exact position of the earth, with its axis pointing to the north pole.

14. "To find the length of the day or night, or the sun's rising or setting, in any latitude; having the day of the month given." Rectify the globe for the latitude of the place; then bring the sun's place on the globe to the meridian, and set the index to twelve at noon, or the upper twelve, and then the globe is in the proper position for noon-day. Next turn the globe about towards the east till the sun's place come just to the wooden horizon, and the index will then point to the hour of sun-rise; also turn the globe as far to the west side, or till the sun's place come just to the horizon on the west side, and then the index will point to the hour of sun-set. These being now known, double the hour of setting will be the length of the day, and double the rising will be the length of the night. And thus also may the length of the longest day, or the shortest day, be found for any latitude.

15. "To find the beginning and end of twilight on any day of the year, for any latitude." It is twilight all the time from sun-set till the sun is eighteen degrees below the horizon, and the same in the morning from the time the sun is eighteen degrees below the horizon till the moment of his rise. Therefore, rectify the globe for the latitude of the place, and for noon by setting the index to twelve, and screw on the quadrant of altitude. Then take the point of the ecliptic opposite the sun's place, and turn the globe on its axis westward, as also the quadrant of altitude, till that point cut this quadrant in the eighteenth degree below the horizon, then the index will shew the time of dawning in the morning; next turn the globe and quadrant of altitude towards the east, till the said point opposite the sun's place meet this quadrant in the same eighteenth degree, and then the index will shew the time when twilight ends in the evening.

16. "At any given day, and hour of the day, to find all those places on the globe where the sun then rises, or sets, as also where it is noon-day, where it is day-light, and where it is in darkness." Find what place the sun is vertical to, at that time; and elevate the globe according to the latitude of that place, and bring the place also to the meridian; in which state it will also be in the zenith of the globe. Then is all the upper hemisphere, above the wooden horizon, enlightened, or in day light; while all the lower one, below the horizon, is in darkness, or night: those places by the edge of the meridian, in the upper hemisphere, have noon-day, or twelve o'clock; and those by the meridian below, have it midnight: lastly, all those places by the eastern side of the horizon, have the sun just setting, and those by the western horizon have him just rising.

Hence, as in the middle of a lunar eclipse the moon is in that degree of the ecliptic opposite to the sun's place; by the present problem it may be shewn what places of the earth then see the middle of the

eclipse, and what the beginning or ending; by using the moon's place instead of the sun's place in the problem.

17. "To find the bearing of one place from another, and their angle of position." Bring the one place to the zenith, by rectifying the globe for its latitude, and turning the globe till that place come to the meridian; then screw the quadrant of altitude upon the meridian at the zenith, and make it revolve till it come to the other place on the globe; then look on the wooden horizon for the point of the compass, or number of degrees from the south, where the quadrant of altitude cuts it, and that will be the bearing of the latter place from the former, or the angle of position sought.

18. "The day and hour of a solar or lunar eclipse being given, to find all those places in which the same will be visible." Find the place to which the sun is vertical at the given instant, and elevate the globe to the latitude of the place; then, in most of those places above the horizon will the sun be visible during his eclipse; and all those places below the horizon will see the moon pass through the shadow of the earth in her eclipse.

19. "The length of a degree being given, to find the number of miles in a great circle of the earth, and thence the diameter of the earth." Admit that one degree contains $69\frac{1}{2}$ English statute miles; then multiply 360 (the number of degrees in a great circle) by $69\frac{1}{2}$, and the product will be 25,020, the miles which measure the circumference of the earth. If this number be divided by 3.1416, the quotient will be $7{,}963\frac{86}{100}$ miles, for the diameter of the earth.

20. "The diameter of the earth being known, to find the surface in square miles, and its solidity in cubic miles." Admit the diameter be 7,964 miles; then multiply the square of the diameter by 3.1416, and the product will be 199,250,205 very near, which are the square miles in the surface of the earth. Again multiply the cube of the diameter by 0.5236, and the product 264,466,789,170 will be the number of the cubic miles in the whole globe of the earth.

21. "To express the velocity of the diurnal motion of the earth." Since a place in the equator describes a circle of 25,020 miles in twenty-four hours, it is evident, that the velocity with which it moves is at the rate of $1{,}042\frac{1}{2}$ in one hour, or $17\frac{3}{10}$ miles per minute. The velocity in any parallel of latitude, decreases in the proportion of the co-sine of the latitude to the radius. Thus, for the latitude of London, 51° 30′, say,

As radius	10.000000
To the co-sine of lat. 51° 30′	9.794149
So is the velocity in the equator, $17\frac{3}{10}'$	2.238046
To the velocity of the city of London, $10\frac{8}{10}'$	2.032195

That is, the city of London moves about the axis of the earth at the rate of $10\frac{8}{10}$ miles every minute of time: but this is far short of the velocity of the annual motion about the sun; for that is at the rate of more than 65,000 miles per hour.

PROBLEMS ON THE CELESTIAL GLOBE.

1. "To rectify the globe." Raise or elevate the pole to the latitude of the place; screw the quadrant of altitude in the zenith; set the index of the hour-circle to the upper XII; and place the globe north and south by the compass and needle; then is it a just representation of the heavens from the given day at noon.

2. "To find the sun's place in the ecliptic." Find the day of the month in the calendar on the horizon, and right against it is the degree of the ecliptic, which the sun is in for that day.

3. "To find the sun's declination." Rectify the globe, bring the sun's place in the ecliptic to the meridian, and that degree which it cuts in the meridian is the declination required.

4. "To find the sun's right ascension." Bring the sun's place to the meridian, and the degree of the equinoctial cut by the meridian is the right ascension required.

5. "To find the sun's amplitude." Bring the sun's place to the horizon, and the arch of the horizon intercepted between it and the east or west point, is the amplitude, north or south.

6. "To find the sun's altitude for any given day and hour." Bring the sun's place to the meridian; set the hour-index to the upper XII; then turn the globe till the index points to the given hour, where let it stand; then screwing the quadrant of altitude in the zenith, lay it over the sun's place, and the arch contained between it and the horizon, will give the degrees of altitude required.

7. "To find the sun's azimuth for any hour of the day." Every thing being done as in the last problem, the arch of the horizon contained between the north point, and that where the quadrant of altitude cuts it, is the azimuth east or west, as required.

8. "To find the time when the sun rises or sets." Find the sun's place for the given day; bring it to the meridian, and set the hour-hand to XII; then turn the globe till the sun's place touches the east part of the horizon, the index will shew the hour of its rising; after that, turn the globe to the west part of the horizon, and the index will shew the time of its setting for the given day.

9. "To find the length of any given day or night." This is easily known by taking the number of hours between the rising and setting of the sun for the length of the day; and the residue, to twenty-four, for the length of the night.

10. "To find the hour of the day, having the sun's altitude given." Bring the sun's place to the meridian, and set the hour-hand to XII; then turn the globe in such a manner, that the sun's place may move along by the quadrant of altitude (fixed in the zenith) till it touches the degree of the given altitude, where stop it, and the index will shew on the horary circle the hour required.

11. "To find the place of the moon, or any planet, for any given day." Take White's ephemeris, and against the given day of the month you will find the degree and minute of the sign which the moon or planet possesses at noon, under the title of geocentric motions. The degree thus found being marked in the ecliptic on the globe by a small mark, or otherwise, you may then proceed to find the declination, right ascension, latitude, longitude, altitude, azimuth, rising, southing, setting, &c. in the same manner as has been shewn for the sun.

12. "To explain the phenomena of the harvest-moon." In order to this we need only consider, that when the sun is in the beginning of Aries, the full moon on that day must be in the beginning of Libra; and since when the sun sets, or moon rises, on that day, those equinoctial points will be in the horizon, and the ecliptic will then be least of all inclined thereto, the part or arch which the moon describes in one day, *viz.* 13°, will take up about an hour and a quarter ascending above the horizon; and, therefore, so long will be the time after sun-set, the next night, before the moon will rise. But at the opposite time of the year, when the sun is in the autumnal, and the full moon in the vernal equinox, the ecliptic will, when the sun is setting, have the greatest inclination to the horizon; and therefore, 13° will in this case soon ascend, *viz.* in about a quarter of an hour; and so long after sun-set will the moon rise the next day after the full: whence, at this time of the year, there is much more moon-light than in the spring; and hence this autumnal full moon came to be called the harvest-moon, the hunter's or shepherd's moon: all which may be clearly shewn on the globe.

13. "To represent the face of the starry firmament for any given hour of the night." Rectify the globe, and turn it about, till the index points to the given hour; then will all the upper hemisphere of the globe represent the visible half of the heavens, and all the stars on the globe will be in such situations as exactly correspond to those in the heavens; which may therefore be easily found, as will be shewn in the sixteenth problem.

14. "To find the hour when any known star will rise, or come upon the meridian." Rectify the globe, and set the index to XII; then turn the globe till the star comes to the horizon or meridian, and the index will shew the hour required.

15. "To find at what time of the year any given star will be on the meridian at XII at night." Bring the star to the meridian, and observe what degree of the ecliptic is on the north meridian under the horizon; then find in the calendar on the horizon the day of the year against that degree, and it will be the day required.

16. "To find any particular star." First find its altitude in the heavens by a quadrant, and the point of the compass it bears on; then, the globe being rectified, and the index turned to the given hour, if the quadrant of altitude be fixed on the zenith, and laid towards the point of the compass on which the star was observed, the star required will be found at the same degree of altitude on the said quadrant, as it was by observation in the heavens.

The invention of globes is of great antiquity. Some allusions to the celestial globe may be found as early as Hipparchus's time, in the writings of Pliny and Ptolemy. Strabo makes mention of the terrestrial globe; and a contemporary of his, Propertius, refers directly to depicted worlds; and Claudius, who describes Archimedes' glass sphere, evinces great knowledge of the constructions of an orrery, spheres, &c. that then existed among mathematicians.

Among the improvers and makers of globes may be subsequently ranked the following, as chief: Tycho Brahe, Regiomon-

tanus, Schonerus, Gemma Fricius, Gr. Mercator, J. Hondius, Johnsonius, Wm. Saunderson, Wm. Bleau, &c.; some of whom wrote learnedly on their uses: but, in this respect, the preference is certainly due to our countryman, Mr. Robert Hues, whose Latin treatise was afterwards published by Handinus, and then by Pontanus with figures and notes. This work was afterwards translated into English by J. Chilmead, in the year 1639.

No globes had any pretensions to acccuracy, taste, or elegance, till the time of Mr. John Senex, F. R. S.: who, about the year 1739, delineated and engraved sets of plates for globes of nine, twelve, seventeen, and twenty-eight inches in diameter, which he used with the globes then manufactured by himself, and making these instruments more accurate and useful than any former maker. The terms and names of places on the globes of seventeen and twenty-eight inches in diameter were in Latin.

About the year 1759, and just after the decease of Mr. Senex, Mr. Benjamin Martin, a learned optician, became possessed of Mr. Senex's plates, and continued for many years to manufacture the globes, but with additional skill, and with various improvements.

About the year 1765, the late Mr. George Adams caused new plates for eighteen and and twelve inches globes to be engraved. The terms and names of these, like the larger ones of Senex, were printed in Latin. Instead of horary circles fixed on the meridian, with moveable indices for computation of time, Mr. Adams contrived circular wires, to envelope the globe about the equinoctial circles, with sliding brass points; so that, as the globes were revolved on their axis, the time by these was pointed out on the graduations of the above great circle; which consequently gave a more extensive and conspicuous scale of time, than could be had by means of the smaller horary circles. He also applied to each globe a semicircular slip of brass, connected at the poles, having on the terrestrial a sliding compass, bearing circle; and on the celestial a small sliding sun. The brass slips were graduated each way from the equinoctial, so the positions for rhomb-lines, right ascensions, and declinations, could be better and more readily obtained.

The horary, or hour circle, of the globes being usually attached to the external edge of the meridians, prevented a free and uninterrupted motion of the meridians, with their poles through the horizons of the globes, to admit of an universal position of the axis, with respect to the horizon, for all latitudes of places. Mr. James Harris, of the Mint, in the year 1740, contrived a method of fixing the brass horary circles at the poles, under the meridians; *i. e.* between the surface of the globes and interior edge of the meridian, and to be occasionally moveable, independent either of the globe or meridian. In this manner the globes were rendered completely useful for the solution of problems in all latitudes.

About the year 1785, Mr. G. Wright contrived a moveable index, applicable to the poles of a globe, to act in a similar manner to the circle of Mr. Harris, which pointed to a circle of hours engraved round the poles of each globe. This he considered a method of obviating the great friction, or adherence, that sometimes inconveniently takes place between the surfaces of the circle and globe.

From the lapse of years, the numerous astronomical and geographical discoveries, and the Latin terms adopted in the larger globes of Senex and Adams, these globes became inconvenient, embarrassing, and finally obsolete. A short time before the year 1800, sets of new and accurately engraved plates were suggested, and considered as a desideratum in astronomy by the Astronomer Royal, Dr. Maskelyne, Sir Joseph Banks, Professor Vince and others; and conformably to this object, in the year 1800 were completed and produced a set of entirely new plates for globes of eighteen inches in diameter, and under the denomination of the "New British Globes." The graduations and lines are laid down in the most correct manner, and with much greater accuracy than in any former globe plates. The drawing from which the terrestrial is engraved, was an entirely new one, from the hands of Mr. Arrowsmith, an eminent geographer. The latitudes and longitudes of places are rectified from the latest and best authorities; and there are likewise inserted all the authentic discoveries to the present time. The celestial globe contains a description of a complete catalogue of stars, clusters, planetary, nebula, &c. to the amount of nearly 6,000, from the observations and communications of Dr. Maskelyne, Dr. Herschel, Rev. Mr. Wollaston, &c., and inserted from calculations made by Mr. W. Jones, optician of Holborn, in their exact positions, to the present period. To the principal stars are annexed Bayer's Greek letters of

reference; and the whole are circumscribed by well-designed figures of the constellations, faintly engraved.

The great circles are divided into twenty minutes of a degree, and the equinoctial in addition into two minutes of time, so that, by estimation, the solution of problems may be obtained to five minutes of a degree, or half a minute of time; a degree of accuracy sufficiently useful not only for all the common problems, but most of the trigonometrical ones.

As the reading off of time is found to be a ready and convenient method by hour circles attached to the meridians, the horary circle has been contrived to admit of being slid away from its pole, upon the exterior edge of the meridian; this is done by making the extremity of the pole, which carries the index of the horary circle, moveable by unscrewing. The horary circle being attached to the meridian barely by springs, when the index is unscrewed, the circle may consequently be slid to any part of the meridian. This contrivance is necessary only for the circle of the north pole of Messrs. W. and S. Jones's terrestrial globe, who have adopted this circle, and at the south pole of the globes have applied the interior brass index, or circles abovementioned.

Plates for the British globes of twelve inches diameter, have been reduced and abridged, from the eighteen inches abovementioned. Plates for globes of nine, twelve, and twenty-one inches diameter, have been engraved by Mr. Cary, of the Strand. The stars of his celestial globe are not circumscribed with the figures of the constellations.

GLOBULAR *chart*, a name given to the representation of the surface, or of some part of the surface of the terrestrial globe upon a plane, wherein the parallels of latitude are circles nearly concentric, the meridians curves bending towards the poles, and the rhomb-lines are also curves.

GLOBULAR *sailing*. See SAILING.

GLOBULARIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Lysimachiæ, Jussieu. Essential character: calyx common, imbricate; proper tubular inferior; corollets the upper lip, two-parted; lower three-parted; receptacle chaffy. There are eight species.

GLORIOSA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Sarmentaceæ. Lilia, Jussieu. Essential character: corolla six-petalled, waved, reflex; style oblique. There are two species, *viz.* G. superba, superb lily, and G. simplex.

GLOSS, in matters of literature, denotes an exposition or explication of the text of any author, whether in the same language, or any other; in which sense it differs little from commentary.

GLOSSOMA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rhamni, Jussieu. Essential character: calyx turbinate four-toothed, superior; corolla four-petalled; anthers almost united, with a membranaceous scale at the end; stigmas four, drupe. There is only one species, *viz.* G. guianensis, a native of Guiana, flowering in September. Votomita is the vernacular name.

GLOSSOPETALUM, in botany, a genus of the Pentandria Pentagynia class and order. Natural order of Rhamni, Jussieu. Essential character: calyx very small, five-toothed; petals five, with a strap at the tip of each; berry. There are two species, both lofty trees, natives of Guiana and Cayenne.

GLOTTIS, in anatomy, the mouth or aperture of the larynx, through which the air ascends and descends in respiring. It can be dilated or contracted at pleasure, and by the various vibratory motions of which the tones of the voice are modified. The name was applied by the ancients to an additional moveable part of the flute, which they placed between their lips in performance, and which is supposed to have been similar to our reed.

GLOW *worm*. See LAMPYRIS.

GLOXINIA, in botany, so called in honour of Ben. Petr. Gloxin, of Colmar, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Campanulaceæ, Jussieu. Essential character: calyx superior, five-leaved; corolla bell-shaped, with the border oblique; filaments, with the rudiment of a fifth, inserted into the receptacle. There is only one species, *viz.* G. maculata, spotted gloxinia, a native of South America.

GLUCINA, in chemistry, an earth lately discovered by Vauquelin, while he was analizing the beryl, to ascertain whether its constituent parts were the same as those of the emerald. See BERYL. In this experiment he found the glucina, which he so named from its sweetish kind of taste. Glucina, in the form of powder, or in fragments, is almost three times as heavy as

water; it is infusible in the fire; it does not contract, like alumina, by great heat, and it has no effect on vegetable colours. The oxygen, nitrogen, and hydrogen gases have no action on it; nor is it acted upon by carbon, sulphur, or phosphorus. It combines with sulphurated hydrogen. It is insoluble in water, but combines with acids, making with them soluble salts, distinguished by a sweet and slightly astringent taste.

GLUE, among artificers, a tenaceous viscid matter, which serves as a cement to bind or connect things together. Glues are of different kinds, according to the various uses they are designed for, as the common glue, glove glue, parchment glue, isinglass glue, &c.

The common or strong glue is chiefly used by carpenters, joiners, cabinet-makers, &c. and the best kind is that made in England, in square pieces of a ruddy brown colour, and next to this the Flanders glue. It is made of the skins of animals, as oxen, cows, calves, sheep, &c. and the older the creature is, the better is the glue made of its hide. Indeed, whole skins are but rarely used for this purpose, but only the shavings, parings, or scraps of them; or the feet, sinews, &c. That made of whole skins, however, is undoubtedly the best; as that made of sinews is the very worst.

In making glue of parings, they first steep them two or three days in water; then washing them well out, they boil them to the consistence of a thick jelly, which they pass, while hot, through ozier baskets, to separate the impurities from it, and then let stand some time, to purify it further: when all the filth and ordures are settled to the bottom of the vessel, they melt and boil it a second time. They next pour it into flat frames or moulds, whence it is taken out pretty hard and solid, and cut into square pieces or cakes. They afterwards dry it in the wind, in a sort of coarse net; and at last string it, to finish its drying. The glue made of sinews, feet, &c. is managed after the same manner; only with this difference, that they bone and scour the feet, and do not lay them to steep. The best glue is that which is oldest; and the surest way to try its goodness, is to lay a piece to steep three or four days, and if it swell considerably without melting, and when taken out resumes its former dryness, it is excellent. A glue that will hold against fire or water may be made thus: mix a handful of quick lime with four ounces of linseed oil, boil them to a good thickness, then spread it on tin plates in the shade and it will become exceedingly hard, but may be dissolved over a fire, as glue, and will effect the business to admiration.

Glue, *method of preparing and using.* Set a quart of water on the fire, then put in about half a pound of good glue, and boil them gently together till the glue be entirely dissolved, and of a due consistence. When glue is to be used, it must be made thoroughly hot; after which, with a brush dipped in it, besmear the faces of the joints as quick as possible; then clapping them together, slide or rub them lengthwise one upon another, two or three times, to settle them close; and so let them stand till they are dry and firm.

Glue, *parchment,* is made by boiling gently shreds of parchment in water, in the proportion of one pound of the former to six quarts of the latter, till it be reduced to one quart. The fluid is then to be strained from the dregs, and afterwards boiled to the consistence of glue. Isinglass glue is made in the same way; but this is improved by dissolving the isinglass in alcohol, by means of a gentle heat. See Cements.

GLUME. See Botany.

GLUTA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx bell-shaped, deciduous; petals five, glued at bottom to the column of the germ; filaments inserted into the tip of the column; germ sitting on an oblong column. There is only one species, *viz.* G. benghas, a native of Java.

GLUTEN. With the fecula and saccharine matter which compose the principal part of nutritive grain, is another substance approaching more nearly in its characters to animal matter than any other product of the vegetable system. From the resemblance in its properties to the animal principle formerly called gluten, but now described under the term Fibrin (which see) it has received the name of vegetable gluten. It is obtained in largest quantities from wheat, amounting to the twelfth part of the whole grain, by kneading the flour into paste, which is to be washed very cautiously, by kneading it under a jet of water, till the water carries off nothing more, but runs off colourless, what remains is gluten: it is ductile and elastic; it has some resemblance to animal tendon or membrane; it is very tenacious, and may be used as a cement for broken porcelain vessels. It has a peculiar smell, with scarcely any taste. When exposed to the air it

assumes a brown colour, and becomes apparently covered with a coat of oil. When completely dry it resembles glue, and breaks like glass. It is insoluble in water, alcohol, and ether; but the acids dissolve it, and the alkalies precipitate it. It has a strong affinity for the colouring matter of vegetables, and likewise for resinous substances. When kept moist it ferments, and emits a very offensive smell; the vapour blackens silver and lead. Its constituent parts are oxygen, hydrogen, carbon, and azote. It exists, as we have observed, most abundantly in wheat, but it is found in large quantities in many other plants. It is gluten that renders wheat so useful in the art of bread making.

GLYCINE, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx two-lipped; corolla the keel turning back the banner at the tip. There are twenty-five species.

GLYCYRRHIZA, in botany, English *liquorice*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx two-lipped, upper lip three-parted, lower undivided; legume ovate, compressed. There are four species. These are tall growing perennial, herbaceous plants, with the stalks somewhat woody at bottom. The stipules are distinct from the petiole; the flowers in a head or spike from the axils and at the ends of the branches; seed vessel a legume or pod, smooth, hairy, or prickly.

GLYPH, in sculpture and architecture, denotes any canal or cavity, used as an ornament.

GLYSTER, or Clyster among physicians. See Clyster.

GMELINA, in botany, so called in honour of Joh. George Gmelin, professor of natural history at St. Petersburgh, afterwards of Botany at Tubingen, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx slightly four-toothed; corolla four-cleft, bell-shaped; anthers two-parted, two-simple; drupe with a two or three-celled nut. There is but one species, *viz.* G. asiatica.

GNAPHALIUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, with the marginal scales rounded, scariose, coloured; down feathered; receptacle naked. There are sixty-six species: the numerous species of this genus are chiefly under shrubs or herbs; the leaves are alternately placed, generally hoary; the flowers usually terminate the stem and branches in globes or corymbs. The calyx is permanent with yellow or white scales.

GNAT. See Culex.

GNEISS, in mineralogy, is composed principally of felspar, quartz, and mica, forming plates, laid on each other, and separated by thin layers of mica. It differs from granite by being shistose; though, like that, it sometimes contains shorl and garnet. The beds of gneiss sometimes alternate with layers of granular limestone, shistose, hornblende, and porphyry. It is rich in ores, almost every metal has been found in gneiss rocks, either in veins or beds. Mr. Jameson mentions four kinds of gneiss: 1. That which approaches to the granular structure. 2. The waved or undulated. 3. The common; and, 4. The thin slaty; and he says the order of their transition is also that of their relative antiquity, consequently the more granular the structure, the older the rock; and, on the contrary, the more slaty, the newer it is. In the last member of the series is the smallest portion of felspar, and largest of mica; hence its texture is more completely slaty than that of any of the others. The other extremity contains much felspar, and but little mica. The common contains a nearly equal quantity of felspar and quartz.

GNETUM, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Piperitæ. Urticæ, Jussieu. Essential character: male, an ament with scales; corolla none; filaments one, with two anthers: female, an ament with scales; corolla none; style with a bifid stigma; drupe with one seed. There is only one species, *viz.* G. gnemon, a native of the East Indies, where the leaves, male catkins and fruits are eaten.

GNIDIA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Vepreculæ. Thymelææ, Jussieu. Essential character: calyx funnel-form, four-cleft; petals four, inserted into the calyx; seed one, somewhat berried. There are eleven species.

GNOMON, in dialling, the stile, pin, or cock of a dial; which, by its shadow, shows the hour of the day. The gnomon of every dial represents the axis of the world. See Dial and Dialing.

Gnomon, in geometry. If, in a parallelogram (Pl. VI. Miscel. fig. 1.) the diameter, A C, be drawn; also two lines, E F, H I, parallel to the sides of the parallelogram, and cutting the diameter in one and the same point, G, so that the parallelogram is, by these parallels, divided into four parallelograms, then are the two parallelograms, D G, B G, through which the diameter does not pass, called complements; those through which the diameters pass, E H, F I, are called the parallelograms about the diameter; and a gnomon consists of the two complements, and either of the parallelograms about the diameter, *viz.* G D + H E + E I, or G D + F I + G B.

Gnomon, in astronomy, a stile erected perpendicular to the horizon, in order to find the altitude of the sun. Thus, in the right angled triangle A B C, fig. 2, are given, A B, the length of the stile, B C, the length of its shadow, and the right angle, A B C. Hence, making, C B, the radius, we have this analogy for finding the angle, A C B, the sun's altitude, *viz.* B C : A B : : radius : tangent of the angle C.

By means of a gnomon, the sun's meridian altitude, and consequently the latitude of the place, may be found more exactly than with the smaller quadrants.

By the same instrument, the height of any object, G H, may be found; for as, D F, fig. 3, the distance of the observer's eye from the gnomon, is to, D E, the height of the stile, so is, F H, the distance of the observer's eye from the object to, G H, its height.

The gnomon may be made useful in taking the meridian altitude of the sun, and thence finding the latitude of the place. Having a meridian line drawn through the centre of the gnomon, mark the point where the shadow of the gnomon terminates when projected along the meridian line, and measure the distance of that point from the centre of the gnomon, which will be the length of its shadow; then having the height of the gnomon, and the length of the shadow, the sun's altitude is easily found. Thus, if A B be the gnomon, and A C the length of the shadow, then in the right angled triangle, A B C, we have A B and B C given; hence the angle C is easily found, for C B : B A : : radius : tangent of the angle C; that is, as the length of the shadow is to the height of the gnomon, so is radius to the tangent of the sun's altitude above the horizon. *Ex.* We learn from Pliny, at the time of the equinoxes, that the shadow was to the gnomon as $8 : 9$, therefore we say as $8 : 9 : : R : \frac{9}{8} = 1.125$ the tangent of an angle of $48° 22'$, which is the height of the equator at Rome, and its complement $41° 38'$ is therefore the height of the pole, or the latitude of the place. This method, however, requires correction for the sun's parallax, and for refraction.

GNOMONICS, the art of Dialing, which see. From the shadow of a rod, perpendicularly or obliquely placed on a plane, may be determined a triangle, by drawing from the top of the rod a line that shall touch the luminous body, forming with the rod the least possible angle. The sides of the triangle will be, first, the part of this line comprehended between the top of the rod and the given plane; then the rod itself, and lastly, the line drawn from the bottom of the rod till it meets the other line already mentioned. This last line will be the shadow relatively to the given plane: it will increase and decrease in proportion as the sine of the angle, whose summit coincides with the summit of the rod, shall be greater or less, that is, in proportion as the luminous body shall descend or ascend with respect to the given plane; and if that body move to the right or the left of the position first occupied by the triangle, that determines the shadow, which will move on the plane in a contrary direction; and on these principles the art of dialing consists.

GNOSTICS, in church history, a sect of Christians so called from their pretensions to be more enlightened than others, and from their affecting to be able to bring back mankind to the knowledge of the true God. The opinions held by these people have not been completely ascertained; they were fond of speculation, and like many of the gnostics of modern times, held public worship and positive institutions in little esteem.

GOAL, or Gaol. See Gaol.

GOAT, in zoology. See Capra. These animals require scarcely any thing to keep them. Their milk is esteemed the greatest nourisher of all liquids, women's milk excepted, and very comfortable to the stomach. The young kids also are very good for the table, and may be managed in all respects like lambs.

Goat's *beard*, in botany. See Tragopogon.

Goat *sucker*. See Caprimulgus. These birds are regarded by the American Indians as very ominous. They believe that goat-suckers were not known in their coun-

try till the English had made depredation upon it, and that they are, in fact, the departed spirits of the murdered Indians. In Carolina the lower class of people look upon them as birds of ill omen, and are gloomy and almost melancholy if one alights on the house or near the door, and begins its call, which they will sometimes do, even on the very threshold, imagining that it is a sure prognostic of the death of one of the family.

GOBIUS, the *goby*, in natural history, a genus of fishes of the order Thoracici. Generic character: head small; eyes approximated, with two punctures between them; gill membrane, four-rayed; ventral fins, united into a funnel-like oval; dorsal fins two. There are twenty-five species, of which we shall notice the following, G. niger, or the black goby, is about six inches in length. It inhabits the Mediterranean and North Seas, and often, in summer, when it deposits its spawn enters the mouths of rivers for that purpose. It is eaten, but not highly valued. The ventral fins unite into a species of funnel, by which this fish is said often to attach itself almost inseparably to stones and rocks. It lies chiefly under stones; and its food consists of worms, insects, and the young of small fishes. For another species, the lanceolated goby, see Pisces, Plate IV. fig. 4.

GOD, *Deus*, the Supreme Being, the first cause or creator of the universe, and the only true object of religious worship. The Hebrews called him Jehovah; which name they never pronounced, but used instead of it the words Adonai, or Elohim.

God, says Sir Isaac Newton, is a relative term, and has respect to servants. It denotes, indeed, an eternal, infinite, absolutely perfect being: but such a being without dominion, would not be God. The word God frequently signifies lord, but every lord is not God. The dominion of a spiritual being, or lord, constitutes God; true dominion, true God. From such true dominion it follows that the true God is living, intelligent, and powerful; and from his other perfections, that he is supreme, or supremely perfect. He is eternal and infinite; omnipotent and omniscient; that is, he endures from eternity to eternity, and is present from infinity to infinity. He governs all things that exist, and knows all things that are to be known. He is not eternity or infinity, but eternal and infinite. He is not duration and space, but he endures and is present; he endures always, and is present every where; and by existing always and every where, constitutes the very things we call duration and space, eternity and infinity. He is omnipresent, not only virtually, but substantially; for power without substance cannot subsist. All things are contained and move in him, but without any mutual passion; that is, he suffers nothing from the motions of bodies, nor do they undergo any resistance from his omnipresence.

It is confessed, that God exists necessarily; and by the same necessity he exists always and every where. Hence also he must be perfectly similar; all eye, all ear, all brain, all arm, all perception, intelligence, and action; but after a manner not at all corporeal, not at all like men; after a manner altogether unknown to us. He is destitute of all body and bodily shape, and therefore cannot be seen, heard, or touched; nor ought to be worshipped under the representation of any thing corporeal. We know him only by his properties, or attributes, by the most wise and excellent structure of things, and by final causes: but we adore and worship him only on account of his dominion; for God setting aside dominion, providence, and final causes, is nothing but fate and nature.

The plain argument, says Mr. Maclaurin, for the existence of the deity, obvious to all, and carrying irresistible conviction with it, is from the evident contrivance and fitness of things for one another, which we meet with throughout all parts of the universe. There is no need of nice or subtle reasonings in this matter; a manifest contrivance immediately suggests a contriver. It strikes us like a sensation, and artful reasonings against it may puzzle us, but without shaking our belief. No person, for example, that knows the principles of optics and the structure of the eye, can believe that it was formed without skill in that science, or that the ear was formed without the knowledge of sounds, or that the male and female, in animals, were not formed for each other, and for continuing the species. All our accounts of nature are full of instances of this kind. The admirable and beautiful structure of things for final causes, exalt our idea of the contriver: the unity of design shows him to be one. The great motions in the system, performed with the same facility as the least, suggest his almighty power, which gave motion to the earth and the celestial bodies with equal ease as to the minutest particles. The subtilty of the motions and actions in the internal parts of bodies, shows that his influence penetrates the in-

most recesses of things, and that he is equally active and present every where. The simplicity of the laws that prevail in the world, the excellent disposition of things in order to obtain the best ends, and the beauty which adorns the works of nature, far superior to any thing in art, suggest his consummate wisdom. The usefulness of the whole scheme, so well contrived for the intelligent beings that enjoy it, with the internal disposition and moral structure of those beings themselves, show his unbounded goodness. These are the arguments which are sufficiently open to the views and capacities of the unlearned; while, at the same time, they acquire new strength and lustre from the discoveries of the learned.

The Deity's acting and interposing in the universe show that he governs as well as formed it; and the depth of his counsels, even in conducting the material universe, of which a great part surpasses our knowledge, keep up an inward veneration and awe of this great being, and dispose us to receive what may be otherwise revealed to us concerning him. It has been justly observed that some of the laws of nature now known to us must have escaped us if we had wanted the sense of seeing. It may be in his power to bestow upon us other senses, of which we have at present no idea; without which it may be impossible for us to know all his works, or to have more adequate ideas of himself. In our present state we know enough to be satisfied of our dependency upon him, and of the duty we owe to him, the Lord and Disposer of all things. He is not the object of sense; his essence, and indeed that of all other substances, is beyond the reach of all our discoveries: but his attributes clearly appear in his admirable works. We know that the highest conceptions we are able to form of them are still beneath his real perfections; but his power and dominion over us, and our duty towards him, are manifest.

"Though God has given us no innate ideas of himself," says Mr. Locke, "yet having furnished us with those faculties our minds are endowed with, he hath not left himself without a witness; since we have sense, perception, and reason, and cannot want a clear proof of him, as long as we carry ourselves about us. To show, therefore, that we are capable of knowing, that is, being certain that there is a God, and how we may come by this certainty, I think we need go no further than ourselves, and that undoubted knowledge we have of our own existence. I think it is beyond question that man has a clear perception of his own being; he knows certainly that he exists, and that he is something. In the next place, man knows, by an intuitive certainty, that bare nothing can no more produce any real being than it can be equal to two right angles. If, therefore, we know there is some real being, it is an evident demonstration, that from eternity there has been something: since what was not from eternity had a beginning, and what had a beginning must be produced by something else. Next it is evident that what has its being from another, must also have all that which is in and belongs to its being from another too: all the powers it has must be owing to, and received from, the same source. This eternal source then of all beings, must be also the source and original of all power; and so this eternal being must be also the most powerful.

"Again, man finds in himself perception and knowledge: we are certain then that there is not only some being, but some knowing intelligent being, in the world. There was a time then when there was no knowing being, or else there has been a knowing being from eternity. If it be said, there was a time when that eternal being had no knowledge; I reply, that then it is impossible there should have ever been any knowledge; it being as impossible that things wholly void of knowledge, and operating blindly, and without any perception, should produce a knowing being, as it is impossible that a triangle should make itself three angles bigger than two right ones. Thus, from the consideration of ourselves, and what we infallibly find in our own constitutions, our reason leads us to the knowledge of this certain and evident truth, that there is an eternal, most powerful, and knowing Being, which whether any one will call God, it matters not. The thing is evident; and from this idea, duly considered, will easily be deduced all those other attributes we ought to ascribe to this eternal Being.

"From what has been said, it is plain to me, that we have a more certain knowledge of the existence of a God than of any thing our senses have not immediately discovered to us. Nay, I presume I may say, that we more certainly know that there is a God, than that there is any thing else without us. When I say we know, I mean there is such a knowledge within our reach

which we cannot miss, if we will but apply our minds to that as we do to several other inquiries.

"It being then unavoidable for all rational creatures to conclude that something has existed from eternity, let us next see what kind of a thing that must be. There are but two sorts of beings in the world that man knows or conceives; such as are purely material, without sense or perception; and sensible perceiving beings, such as we find ourselves to be. These two sorts we shall call cogitative and incogitative beings; which, to our present purpose, are better than material and immaterial.

"If then there must be something eternal, it is very obvious to reason that it must necessarily be a cogitative being; because it is as impossible to conceive that bare incogitative matter should ever produce a thinking intelligent being, as that nothing of itself should produce matter. Let us suppose any parcel of matter eternal, we shall find it in itself unable to produce any thing. Let us suppose its parts firmly at rest together; if there were no other being in the world, must it not eternally remain so, a dead unactive lump? is it possible to conceive that it can add motion to itself, or produce any thing? Matter then, by its own strength, cannot produce in itself so much as motion. The motion it has must also be from eternity, or else added to matter by some other being more powerful than matter. But let us suppose motion eternal too; but yet matter, incogitative matter, and motion could never produce thought. Knowledge will still be as far beyond the power of nothing to produce. Divide matter into as minute parts as you will, vary its figure and motion as much as you please, it will operate no otherwise upon other bodies, of proportionable bulk, than it did before this division. The minutest particles of matter repel and resist one another just as the greater do, and that is all they can do; so that if we suppose nothing eternal, matter can never begin to be; if we suppose bare matter without motion eternal, motion can never begin to be; if we suppose only matter and motion eternal, thought can never begin to be; for it is impossible to conceive that matter, either with or without motion, could have, originally in and from itself, sense, perception, and knowledge, as is evident from hence, that then sense, perception, and knowledge, must be a property eternally inseparable from matter, and every particle of it. Since, therefore, whatsoever is the first eternal being, must necessarily be cogitative; and whatsoever is first of all things must necessarily contain in it, and actually have, at least, all the perfections that can ever after exist; it necessarily follows that the first eternal being cannot be matter. If, therefore, it be evident that something must necessarily exist from eternity, it is also as evident that that something must be a cogitative being. For it is as impossible that incogitative matter should produce a cogitative being, as that nothing, or the negation of all being, should produce a positive being or matter.

"This discovery of the necessary existence of an eternal mind sufficiently leads us to the knowledge of God; for it will hence follow that all other knowing beings that have a beginning must depend on him, and have no other ways of knowledge, or extent of power, than what he gives them; and, therefore, if he made those, he made also the less excellent pieces of this universe, all inanimate bodies, whereby his omniscience, power, and providence, will be established; and from thence all his other attributes necessarily follow."

With respect to Christians, it need only be just mentioned, that they were very early divided in opinion as to the nature and essence of the Supreme Being; a great part worshipping three persons in the unity of the godhead, whilst others absolutely rejected a trinity of persons, and asserted the unity of the divine nature, both as to person and substance.

With respect to the theology of the Pagans, it is thought by most learned men that they acknowledged but one God; and that the many different divinities worshipped by them were but attributes and actions of one and the same God. This may probably be true of the wiser Heathens; and, indeed, there are many strong and beautiful passages in Pagan authors, to prove that these acknowledged but one God. Thus Pythagoras taught the unity of God, and defined him to be a mind penetrating and diffusing itself through all the parts of the universe, from which all animals receive life; and Plato called God the being which is; and whenever he mentions the Deity it is always in the singular number.

GOGGLES, in surgery, instruments used for the cure of squinting, or that distortion of the eyes which occasions this disorder. They are short conical tubes, composed of ivory stained black, with a thin plate of the

same ivory fixed in the tubes; through the centre of the plates is a small circular hole, about the size of the pupil of the eye, for the transmission of the rays of light. These goggles must be worn regularly and constantly, till the muscles of the eye are brought to act properly and uniformly, so as to direct the pupil straight forward.

GOLD is a yellow metal, of much greater specific gravity than any other body in nature, except platina. It is soft, very tough, ductile, and malleable; unalterable and fixed, whether exposed to the atmosphere, or to the strongest heat of furnaces. The most powerful burning mirrors are said to have volatilized it; and it has been driven up in fumes, in the metallic state, by flame urged upon it by a stream of oxygen gas. The electric shock converts it into a purple oxide, as may be seen by transmitting that commotion through gold leaf between two plates of glass; or by causing the explosive spark of three or more square feet of coated glass to fall upon a gilded surface. A strong heat is required to melt it, which does not happen till after ignition. Its colour, when melted, is of a blueish green; and the same colour is exhibited by light transmitted through gold-leaf.

The limits of the ductility and malleability of gold are not known, and its tenacity exceeds that of any other metal. A gold wire of one tenth of an inch diameter, requires 500*lb.* weight to break it.

The method of extending gold used by the gold-beaters, consists in hammering a number of thin-rolled plates between skins or animal membranes. By the weight and measure of the best wrought gold-leaf, it is found, that one grain is made to cover $56\frac{3}{4}$ square inches; and from the specific gravity of the metal, together with this admeasurement, it follows, that the leaf itself is $\frac{1}{282000}$ parts of an inch thick. This, however, is not the limit of the malleability of gold; for the gold-beaters find it necessary to add three grains of copper in the ounce to harden the gold, which otherwise would pass round the irregularities of the newest skins, and not over them; and in using the old skins, which are not so perfect and smooth, they proceed so far as to add twelve grains. The wire which is used by the lace-makers is drawn from an ingot of silver, previously gilded. In this way, from the known diameter of the wire, or breadth when flattened, and its length, together with the quantity of gold used, it is found, by computation, that the covering of gold is only one-twelfth part of the thickness of gold-leaf, though it still is so perfect as to exhibit no cracks when viewed by a microscope.

No acid acts readily upon gold but the nitro-muriatic acid, called aqua-regia, and the oxygenized-muriatic acid. The sulphuric acid, distilled from manganese, has some action upon it; as have likewise the pale nitric acid, and the phosphoric acid when boiling. Chromic acid added to the muriatic enables it to dissolve gold.

The small degree of concentration of which the oxygenized-muriatic acid is susceptible, and the imperfect action of the latter acids, render aqua-regia the most convenient solvent for this metal.

When gold is immersed in aqua-regia, an effervescence takes place with the escape of gas; the solution tinges animal matters of a deep purple, and corrodes them. By careful evaporation, fine crystals of a topaz colour are obtained. The gold is precipitated from its solvent by a great number of substances. Lime and magnesia precipitate it in the form of a yellowish powder. Alkalies exhibit the same appearance; but an excess of alkali redissolves the precipitate. The precipitate of gold obtained from aqua-regia, by the addition of a fixed alkali appears to be a true oxide, and is soluble in the sulphuric, nitric, and muriatic acids; from which, however, it separates by standing, or by evaporation of the acids. Gallic acid precipitates gold of a reddish colour, very soluble in the nitric acid, to which it communicates a fine blue colour.

Ammonia precipitates the solution of gold much more readily than fixed alkalies. This precipitate, which is of a brown, yellow, or orange colour, possesses the property of detonating with a very considerable noise, when gently heated. It is known by the name of fulminating gold. The presence of ammonia is necessary to give the fulminating property to the precipitate of gold; and it will be produced by precipitating it with fixed alkali from an aqua-regia previously made by adding sal ammoniac to nitric acid; or by precipitating the gold from pure aqua-regia, by means of sal ammonia, instead of the ammonia alone. The fulminating gold weighs one-fourth more than the gold made use of. A considerable degree of precaution is necessary in preparing this substance. It ought not to be dried but in the open air, at a distance from a fire, because a very gentle heat may cause it to explode. Several fatal accidents have

arisen from its explosion, in consequence of the friction of ground stoppers in bottles containing this substance, of which a small portion remained in the neck.

Fulminating gold, when exposed by Berthollet to a very gentle heat in a copper tube, with the pneumatical apparatus of mercury, was deprived of its fulminating quality, and converted into an oxide at the same time that ammoniacal gas was disengaged. From this dangerous experiment it is ascertained, that fulminating gold consists of oxide of gold combined with ammonia. The same eminent philosopher caused fulminating gold to explode in copper vessels. Nitrogen gas was disengaged, a few drops of water appeared, and the gold was reduced to the metallic form. In this experiment he infers, that the ammonia was decomposed; that the nitrogen, suddenly assuming the elastic state, caused the explosion, while the oxygen of the oxide united with the hydrogen of the alkali, and formed the water.

This satisfactory theory was still farther confirmed by the decomposition of fulminating gold, which takes place in consequence of the action of the concentrated sulphuric acid, of melted sulphur, fat oils, and ether; all of which deprived it of its fulminating quality, by combining with its ammonia.

Sulphurets precipitate gold from its solvent, the alkali uniting with the acid, and the gold falling down combined with the sulphur; of which, however, it may be deprived by moderate heat.

Most metallic substances precipitate gold from aqua-regia: lead, iron, and silver, precipitate it of a deep and dull purple colour; copper and iron throw it down in its metallic state; bismuth, zinc, and mercury, likewise precipitate it. A plate of tin, immersed in a solution of gold, affords a purple powder, called the purple powder of Cassius, which is used to paint in enamel. There are various methods of managing this process. That described by Macquer consists in dissolving tin by very small portions at a time, without heat, in an aqua-regia composed of two parts of nitric and one of muriatic acid, previously weakened with water equal in weight to both the acids. The first small portion of tin must be suffered to be entirely dissolved before a second is added. This addition must be continued till the acid has acquired a yellow colour, and scarcely acts at all upon the tin last added.

On the other hand, the purest gold must be dissolved in an aqua-regia, composed of three parts of nitric and one of muriatic acid. This solution may be made, as expeditiously as the operator chooses, by the assistance of the heat of a sand bath.

The solution of tin must then be largely diluted, as for example, with one hundred parts of distilled water; and a small quantity of this may then be assayed, by separating it in two parts, and diluting one of the parts still farther. Upon trial of both, by letting fall a drop of the solution of gold into each, it will be seen which affords the most beautiful purple precipitate. The whole of the solution of tin must accordingly be altered, if necessary, by adding more water. Pour into this solution, in a large glass or earthen vessel, nearly half as much of the solution of gold as it contains of solution of tin, stirring the mixture with a glass stick. In a short time the liquor will become of a beautiful red colour, which will gradually disappear on the subsidence of the precipitate. By adding a small quantity of the solution of tin it will be seen whether the whole of the gold is precipitated. The clear liquor must then be decanted, and the precipitate washed. It consists of metallic gold and oxide of tin, at a maximum in combination, and is the only known substance which has the property of communicating a purple colour to glass. This purple powder is perfectly soluble in ammonia. Nitric acid boiled on it brightens it to a tint approaching that of cinnabar.

The difficulties attending the preparation of this article appear to depend on the state of the tin. If the solution of this metal be made with heat and rapidity, it becomes too much oxyded to adhere to the acid, or to precipitate the gold; and the combination of the two metals, which falls down, varies in colour according as this term is approached: these are the chief circumstances; but there is no doubt that a complete examination of the process would indicate others worthy of notice.

Ether, naphtha, and the essential oils, take gold from its solvent, and form liquors which have been called potable gold. The gold which is precipitated by evaporation of these fluids, or by the addition of sulphate of iron to the solution of gold, is of the utmost purity.

In the dry way, gold resists the action of neutral salts, more especially nitre, which deflagrates with the imperfect metals.

Nitre, however, does not afford an expeditious way of purifying gold, because this metal in some measure protects and covers the alloys from its action. It is remarked that borax, used as a flux with gold, renders it paler; and that this alteration of colour disappears by the addition of nitre or common salt. As the acid of borax forms a compound with gold, which falls to the bottom when this acid is added to the metal in solution, it is probable that the paleness produced by borax may arise from the combination of a small portion of its acid with the gold, which might be driven off by a continuance of the heat, and united by stronger affinity with the alkali of the nitre, or of the common salt, in proportion as their acids are dissipated by heat.

Earths and alkalies do not act on gold in the dry way. Sulphur, which combines with most metals, has no effect on this. A process, called dry-parting, is grounded on this property; and is more especially used in separating silver from gold, when the quantity of the latter metal is too small to answer the expense of dissolving the larger mass of silver in nitric acid. For this purpose the mixed metal is fused, and flowers of sulphur thrown on its surface. These combine with the silver in the form of a black scoria, while the gold remains at the bottom in its metallic state. The operation of dry-parting does not leave the gold in a state of purity; because the last portions of silver are defended from the action of the sulphur. But when the quantity of silver is thus diminished the operation of parting with aqua-fortis, or nitric acid, may be advantageously used.

Sulphuret of potash dissolves gold in the dry way. Equal parts of sulphur and potash are hastily fused with one-fourth of a part of gold leaf. This combination is soluble in water, with which it forms a yellowish green solution. By the addition of an acid the gold is thrown down in combination with the sulphur, of which it may be deprived by heat.

Most metals unite with gold by fusion. With silver it forms a compound, which is paler in proportion to the quantity of silver added. It is remarkable that a certain proportion, for example, a fifth part renders it greenish. From this circumstance, as well as from that of a considerable proportion of these metals separating from each other by fusion, in consequence of their different specific gravities, when their proportions do not greatly differ it should seem that their union is little more than a mere mixture without combination; for, as gold-leaf transmits the green rays of light, it will easily follow that particles of silver, enveloped in particles of gold, will reflect a green instead of a white light.

A strong heat is necessary to combine platina with gold: it greatly alters the colour of the gold if its weight exceed the forty-seventh part of the mass. Mr. Francillon, however, informs us, that six parts of gold and one of malleable platina produce a metal of a beautiful colour, great malleability, susceptible of a fine polish, and more unalterable than gold itself. It does not much affect the ductility. The Spanish ministry has prohibited the exportation of platina from America, lest it should be used in adulterating gold; but this does not appear to be a danger which need be feared, as chemistry has long been in possession of several simple and expeditious methods of detecting this fraud, which besides is evident to the sight when the quantity of debasement is considerable. It may be questioned likewise whether the value of platina would not soon equal that of gold, if its properties and uses were better known in society. Gold made standard by platina, and hammered, is tolerably elastic.

Mercury is strongly disposed to unite with gold, in all proportions with which it forms an amalgam: this, like other amalgams, is softer, the larger the proportion of mercury. It softens and liquefies by heat, and crystallizes by cooling.

Lead unites with gold, and considerably impairs its ductility, one-fourth of a grain to an ounce rendering it completely brittle. Copper renders gold less ductile, harder, more fusible, and of a deeper colour. This is the usual addition in coin, and other articles used in society. Tin renders it brittle in proportion to its quantity; but it is a common error, of chemical writers, to say that the slightest addition is sufficient for this purpose. When alloyed with tin, however, it will not bear a red heat. With iron it forms a grey mixture, which obeys the magnet. This metal is very hard, and is said to be much superior to steel for the fabrication of cutting instruments. Bismuth renders gold white and brittle; as do likewise nickel, manganese, arsenic, and antimony. Zinc produces the same effect; and, when equal in weight to the gold, a metal of a fine grain is produced, which is said to be well adapted to form the mirrors

of reflecting telescopes, on account of the fine polish it is susceptible of, and its not being subject to tarnish. The alloys of gold with molybdena are not known. It could not be mixed with tungsten on account of the infusibility of this last substance. Mr. Hatchett gives the following order of different metals, arranged as they diminish the ductility of gold; bismuth, lead, antimony, arsenic, zinc, cobalt, manganese, nickel, tin, iron, platina, copper, silver. The first three were nearly equal in effect; and the platina was not quite pure.

For the purposes of coin, Mr. Hatchett considers an alloy of equal parts of silver and copper as to be preferred, and copper alone as preferable to silver alone.

Gold is found mostly in the metallic state, though generally alloyed with silver, copper, iron, or all three. It is found either in separate lumps, or visible grains, among the sands of rivers, in many parts of Europe and elsewhere. The quantity is, for the most part, insufficient to pay the cost of separating it; but it is thought to be more universally diffused in sands and earths than any other metal, except iron. The greatest quantity of gold is imported into Europe from South America. Some is brought from the East Indian islands and China, and some from the coast of Africa. The principal gold mines in Europe are those of Hungary. Some sands afford gold by simple washing; the heavy metallic particles subsiding soonest: but when it is bedded in earths, or stones, these substances are pounded, and boiled with one-tenth of their weight of mercury together with water. The mercury, after a certain time, absorbs the gold, and may be separated by pressure through leathern bags, and subsequent distillation. Or, otherwise, if the sand be heated red hot, and quenched in water several times, for the purpose of cracking and dividing it, and the whole be then melted into glass, with twice its weight of the oxide of lead called litharge, and charcoal powder be then added, the lead will be revived in the metallic state, and will carry the gold along with it. By exposure to a proper degree of heat, with access of air, the lead may again be converted into litharge, and the gold will be left pure. This last operation is, in fact, a method of assaying sands which contain gold, rather than of obtaining it from them in the large way.

Gold is also found in certain martial pyrites in Sweden and elsewhere; from which it may be extracted by torrefaction, or burning of the sulphur, and subsequent digestion in aqua-regia.

To obtain gold in a state of purity, or to ascertain the quantity of alloy it may contain, it is exposed to a strong heat, together with lead, in a porous crucible. This operation is called cupellation.

After gold has passed the cupel, it may still contain either of the other perfect metals, platina or silver. The former is seldom suspected; the latter is separated by the operations called quartation and parting. For all these operations see Assaying.

The quantity of alloy is never considered as part of the value of metals which contain either gold or silver. In estimating or expressing the fineness of gold, the whole mass spoken of is supposed to weigh 24 carats of 12 grains each, either real or merely proportional, like the assayer's weights; and the pure gold is called fine. Thus, if gold be said to be 23 carats fine, it is to be understood that, in a mass weighing 24 carats, the quantity of pure gold amounts to 23 carats.

In such small works as cannot be assayed by scraping off a part, and cupelling it, the assayers endeavour to ascertain its quality or fineness by the touch. This is a method of comparing the colour and other properties of a minute portion of the metal, with those of certain small bars whose composition is known. These bars are called touch-needles; and they are rubbed upon the black basaltes, which, for that reason, is called the touch-stone. Black flint, or pottery, will serve the same purpose. Sets of golden needles may consist of pure gold; pure gold twenty-three and a half carats with half a carat silver; twenty-three carats gold with one carat silver; twenty-two and a half carats gold with one and a half carat silver, and so forth, till the silver amounts to four carats, after which the additions may proceed by whole carats. Other needles may be made in the same manner, with copper instead of silver; and other sets may have the addition, consisting either of equal parts silver and copper, or such proportions as the occasions of business require.

In foreign countries where trinkets and small works are required to be submitted to the assay of the touch, a variety of needles are necessary; but they are not much used in England. They afford, however, a degree of information which is more considerable

than might at first be expected. The attentive assayer not only compares the colour of the stroke made upon the touchstone by the metal under examination with that produced by his needle, but will likewise attend to the sensation of roughness, dryness, smoothness, or greasiness, which the texture of the rubbed metal excites when abraded by the stone. When two strokes, perfectly alike in colour, are made upon the stone, he may then wet them with aqua-fortis, which will affect them very differently if they be not similar compositions; or the stone itself may be made red hot by the fire, or by the blowpipe, if thin black pottery be used, in which case the phenomena of oxydation will differ according to the nature and quantity of the alloy.

Gold ores may be assayed in the moist way by pounding them very fine, weighing a determinate portion, and attempting their solution in nitric acid, which will dissolve the matrix if it consist of calcareous earth; or if it be sulphate of lime the powder may be digested in aqua-regia as long as any metallic substance is taken up; after which the gold may be precipitated by an addition of sulphate of iron, which will cause it to fall down in the metallic state.

The principal use of gold is as the medium of exchange in coin, for which it has been chosen to occupy the first place, on account of its scarcity, its great weight, and its not being subject to tarnish. The gold coins of Great Britain contain eleven parts of gold and one of copper. See Coin.

Gold is likewise used in gilding. See Gilding.

The other uses of gold, in laces, &c. are sufficiently known.

Gold *beating*. See Gold.

Gold *wire*, a cylindrical ingot of silver, superficially gilt, or covered with gold at the fire, and afterwards drawn successively through a great number of little round holes of a wire-drawing iron, each less than the other, till it be sometimes no bigger than a hair of the head. It may be observed, that before the wire be reduced to this excessive fineness, it is drawn through above an hundred and forty different holes, and that each time they draw it, it is rubbed afresh over with new wax, both to facilitate its passage, and to prevent the silver's appearing through it.

Gold *wire flatted*, is the former wire flatted between two rollers of polished steel, to fit it to be spun on a stick, or to be used flat, as it is without spinning, in certain stuffs, laces, embroideries, &c.

Gold *thread*, or *spun gold*, is a flatted gold, wrapped or laid over a thread of silk, by twisting it with a wheel and iron bobbins.

Manner of forming gold wire and gold thread, both round and flat. First, an ingot of silver, of 24 pounds, is forged into a cylinder of about an inch in diameter: then it is drawn through eight or ten holes of a large, coarse, wire-drawing iron, both to finish the roundness, and to reduce it to about three-fourths of its former diameter. This done they file it very carefully all over to take off any filth remaining on the forge; then they cut it in the middle; and thus make two equal ingots thereof, each about 26 inches long, which they draw through several new holes, to take off any inequalities the file may have left, and to render it as smooth and equable as possible.

The ingot thus far prepared, they heat it in a charcoal fire; then taking some gold leaves, each about four inches square, and weighing twelve grains, they join four, eight, twelve, or sixteen of these, as the wire is intended to be more or less gilt, and when they are so joined as only to form a single leaf, they rub the ingots reeking hot with a burnisher. These leaves being thus prepared, they apply over the whole surface of the ingot, to the number of six, over each other, burnishing or rubbing them well down. When gilt, the ingots are laid anew in a coal fire; and when raised to a certain degree of heat, they go over them a second time, both to solder the gold more perfectly and to finish the polishing. The gilding finished, it remains to draw the ingot into wire.

In order to this, they pass it through 20 holes of a moderate drawing-iron, by which it is brought to the thickness of the tag of a lace: from this time the ingot loses its name, and commences gold wire. Twenty holes more of a lesser iron leaves it small enough for the least iron; the finest holes of which last scarcely exceeding the hair of the head, finish the work.

To dispose the wire to be spun on silk, they pass it between two rollers of a little mill: these rollers are of nicely polished steel, and about three inches in diameter. They are set very close to each other, and turned by means of a handle fastened to one of them, which gives motion to the other. The gold wire in passing between the two, is rendered quite flat, but without

losing any thing of its gilding, and is rendered so exceedingly thin and flexible, that it is easily spun on silk thread, by means of a hand wheel, and so wound on a spool or bobin.

GOLDFINCH. See FRINGILLA.

GOLD *size*. See SIZE.

GOLDSMITH, or, as some choose to express it, *silver-smith*, an artist who makes vessels, utensils, and ornaments in gold and silver.

The goldsmith's work is either performed in the mould, or beat out with the hammer, or other engine. All works that have raised figures are cast in a mould, and afterwards polished and finished: plates, or dishes, of silver or gold are beat out from thin flat plates; and tankards, and other vessels of that kind, are formed of plates soldered together, and their mouldings are beat, not cast. The business of the goldsmiths' formerly required much more labour than it does at present; for they were obliged to hammer the metal from the ingot to the thinness they wanted: but there are now invented flatting-mills, which reduce metals to the thinness that is required, at a very small expence. The goldsmith is to make his own moulds, and for that reason ought to be a good designer, and have a taste in sculpture: he also ought to know enough of metallurgy, to be able to assay mixed metals, and to mix the alloy. The goldsmiths in London employ several hands under them for the various articles of their trade: such are the jeweller, the snuff-box and toy-maker, the silver turner, the gilder, the burnisher, the chaser, the refiner, and the gold-beater.

GOLD, *mosaic*, that applied in pannels, on proper ground, distributed into squares, lozenges, and other compartments, part whereof is shadowed to heighten or raise the rest.

GOLD, *shell*, that used by the illuminers to write gold letters. It is made with the parings of leaf-gold, and even of the leaves themselves, reduced into an impalpable powder, by grinding on a marble with honey. After leaving it to infuse some time in aqua-fortis, they put it in shells, where it sticks. To use it they dilute it with gum-water, or soap-water.

GOLD, *pure*, that purged by fire of all its impurities, and all alloy. The moderns frequently call it gold of 24 carats, but in reality there is no such thing as gold so very pure, and there is always wanting at least a quarter of a carat. Gold of 22 carats has one part of silver and another of copper; that of 23 carats has half a part, *i. e.* half a twenty-fourth of each. See CARAT.

GOLDEN *number*, in chronology, a number shewing what year of the moon's cycle any given year is. See CHRONOLOGY.

The rule for finding the golden number is this; add one to the given year, and divide by 19, the quotient is the number of cycles which have revolved since the commencement of the Christian æra, and the remainder will be the golden number for the given year: the golden number for $1809 = \frac{1809+1}{19} = 95$ for the number of cycles, and 5 the remainder will be the golden number: when there is no remainder the golden number is 19.

GOLDEN *rod*. See SOLIDAGO.

GOLDEN *rule*, in arithmetic, is also called the rule of three, and the rule of proportion. See PROPORTION, and RULE OF THREE.

GOMPHIA, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx five-leaved; corolla five-petalled; berries two, on a large receptacle; seed solitary. There are three species.

GOMPHRENA, in botany, *globe amaranth*, a genus of the Pentandria Digynia class and order. Natural order of Amaranthi, Jussieu. Essential character: calyx coloured, outer three-leaved; leaflets two, converging, keeled; petals rude, villose; nectary cylindric, five-toothed; style cloven half way; capsule one-seeded. There are nine species.

GONATOCARPUS, in botany, a genus the Tetrandria Monogynia class and order. Essential character: corolla four-cleft; drupe eight-cornered, one-seeded. There is only one species; *viz.* G. micranthus.

GONDOLA, in naval architecture, a flat kind of boat, very long and narrow, chiefly used on the canals at Venice.

GONG, in music, an instrument used in China, is made of a metal composed of silver, lead, and copper, and its shape is a sort of circular concave. The tone is loud, harsh, and clanging. It is never introduced except on occasion of giving a national cast to the music in which it is employed, or to awaken surprize, and rouse the attention of the company.

GONIOMETRY, a method of measuring angles with a pair of compasses, and that without any scale whatever, except an undivided semicircle. Thus, having any angle

drawn upon paper to be measured, produce one of the sides of the angle backwards behind the angular point; then with a pair of fine compasses describe a pretty large semicircle from the angular point as a centre, cutting the sides of the proposed angle, which will intercept a part of the semicircle. Take then this intercepted part very exactly between the points of the compasses, and turn them successively over upon the arc of the semicircle, to find how often it is contained in it, after which there is commonly some remainder: then take this remainder in the compasses, and in like manner find how often it is contained in the last of the integral parts of the first arc, with again some remainder: find in like manner how often this last remainder is contained in the former; and so on continually till the remainder become too small to be taken and applied as a measure. By this means is obtained a series of quotients, or fractional parts, one of another, which being properly reduced into one fraction, give the ratio of the first arc to the semicircle, or of the proposed angle to two right angles, or 180 degrees, and consequently that angle itself in degrees and minutes. Thus, suppose the angle B A C (Plate VI. Miscel. fig. 4.) be proposed to be measured. Produce B A out towards *f*, and from the centre, A, describe the semicircle *a b e f*, in which *a b* is the measure of the proposed angle. Take *a b* in the compasses, and apply it four times on the semicircle, as at *b*, *c*, *d*, and *e*; then take the remainder *f e*, and apply it back upon *e d*, which is but once, *viz.* at *g*; again, take the remainder *g d*, and apply it five times on *g e*, as at *h*, *i*, *k*, *l*, and *m*; lastly, take the remainder *m e*, and it is contained just two times in *m l*. Hence the series of quotients is 4, 1, 5, 2; consequently the fourth, or last arc, *e m*, is $\frac{1}{2}$ the third, *m l* of *g d*; and therefore the third arc, *g d*, is $\frac{1}{5\frac{1}{2}}$, or $\frac{2}{11}$ths of the second arc, *e f*; and therefore, again this second arc, *e f*, is $\frac{1}{1\frac{2}{11}}$, or $\frac{11}{13}$ of the first arc, *a b*; and consequently this first arc, *a b*, is $\frac{1}{4\frac{11}{13}}$, or $\frac{13}{63}$ds of the whole semicircle *a f*. But $\frac{13}{63}$ds of 180° are $37\frac{1}{7}°$, or 37° 8′ $34\frac{2}{7}$″, which therefore is the measure of the angle sought.

GONIUM, in natural history, a genus of the Vermes Infusoria. Worm very simple, flat, angular, invisible to the naked eye. There are five species, of which G. pectorale is quadrangular, pellucid, with sixteen spherical molecules. It is found in pure water: molecules oval, nearly equal in size, set in a quadrangular membrane like diamonds in a ring, the lower ones larger than the rest.

GONORRHOEA. See MEDICINE.

GOODENIA, in botany, so called in honour of the Rev. Samuel Goodenough, F. R. S. a genus of the Pentandria Monogynia class and order. Natural order of Campanulaceæ, Jussieu. Essential character: corolla longitudinally cloven on the upper side, exposing the organs of fructification; border five-cleft, leaning one way; anther linear; stigma cup-shaped, ciliated; capsule two-celled, two-valved, with a parallel partition; seeds many, imbricated. There are nine species. These plants are all natives of New South Wales, about Port Jackson.

GOOD *behaviour*, in law. Surety for good behaviour, is the bail for any person's good conduct for a certain time; as surety for the peace is a recognizance taken by a competent judge of record for keeping the King's peace.

Justices of the peace may also bind persons of evil fame to their good behaviour, &c. 34 Edward III. c. 1. This statute being penned in such general words, seems to empower justices, not only to bind over those, who seem to be notoriously troublesome, and likely to break the peace, as eves-droppers, &c. but also those who are publicly scandalous, or contumers of justice, &c. as haunters of bawdy-houses, or keepers of lewd-women in their own houses, common drunkards, or those who sleep in the day, and go abroad in the night, or such as keep suspicious company, or such as are generally suspected as robbers, or such as speak contemptuous words of inferior magistrates, as justices of the peace, mayors, &c. not being in the actual execution of their offices; or of inferior officers of justice, as constables, &c. being in the actual execution of their office; but it seems that rash, quarrelsome, or unmannerly words, spoken by one private person to another, unless they directly tend to a breach of the peace, are not sufficient cause to bind a man to his good behaviour.

GOOGINGS, in naval affairs, certain clamps of iron or other metal, bolted on the stern-post, on which to hang the rudder; for this purpose there is a hole in each of them to receive a correspondent spindle, bolted on the back of the rudder, which

turns thereby as on hinges. There are several googings on a ship's posts and rudder, according to her size, and on these the rudder is supported and traverses.

GOOLE, in law books, signifies a breach in a sea-bank, or wall.

GOOSE. See ANAS.

GOOSE *berry*. See RIBES.

GOOSE *neck*, in a ship, a piece of iron fixed on the end of the tiller, to which the laniard of the whip-staff, or the wheel rope comes for steering the ship.

GOOSE *wing*, in the sea-language. When a ship sails before, or with, a quarter-wind on a fresh gale, to make the more haste, they launch out a boom, and sail on the lee-side; and a sail so fitted, is called a goose-wing.

GORDIUS, in natural history, *hair-worm*, a genus of the Vermes Intestina class and order. Body round, filiform, equal, smooth. There are five species. G. aquaticus is from four to six inches long, of a pale brown colour, but darker at the extremities: it is found in stagnant waters, and twists itself into various contortions and knots, and it is said that if it is handled without caution, it will inflict a bite that occasions the whitlow. G. filum is found in the bark of old wooden water-pipes. G. lacteus is white and opaque; found in stagnant waters; when touched it contracts itself in a moment, and afterwards expands as suddenly.

GORDONIA, in botany, *loblolly-bay*, so called from Mr. James Gordon, an eminent nursery man, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvacéæ, Jussieu. Essential character: calyx five-leaved; petals five, united at the base by means of the nectary; filament inserted into the nectary; capsule superior, five-celled; seeds winged. There are three species.

GORE, in heraldry, one of the abatements, which, according to Guillim, denotes a coward. It is a figure consisting of two arch lines drawn one from the sinister chief, and the other from the sinister base, both meeting in an acute angle in the middle of the fess point.

GOREING, in the sea-language, sloping. A sail is cut goreing, when it is cut sloping by degrees, and is broader at the clue, than at the earing, as all top-sails and top-gallant sails are.

GORGE, in fortification, the entrance of the platform of any work.

GORGED, in heraldry, the bearing of a crown, coronet, or the like, about the neck of a lion, a swan, &c. and in that case it is said, the lion or cygnet is gorged with a ducal coronet, &c. Gorged is also used when the gorge, or neck of a peacock, swan, or the like bird, is of a different colour or metal from the rest.

GORGONIA, in natural history, a genus of the Vermes Zoophyta class and order. Animal growing in the form of a plant; stem coriaceous, corky, woody, horny, or bony, composed of glassy fibres, or like stone, striate, tapering, dilated at the base, covered with a vascular or cellular flesh or bark, and becoming spongy and friable when dry; mouths or florets covering the surface of the stem and polype bearing. There are about forty species, of which the following are found in the European seas, *viz.* G. placomus: branching both ways, with flexuous, rarely anastomosing branches, covered with conic florets. The stem is erect, the branches flattish, bending towards each other; florets surrounded at the top with small spines. G. anceps: slightly branched, with compressed stem and branches, each with rows of florets along both margins. It inhabits the American and British coasts, nearly two feet high; flesh calcareous; bone of horny leathery texture; when recent of a fine violet colour, but when dry, yellowish or white. G. flabellum, Venus's fan: reticulate with the branches compressed on the inner side; bark yellow or purplish; bone black and horny. It inhabits most seas, and is often several feet high, and expanded into a large surface; trunk and branches pinnate, and by means of the smaller branches blending together, forming an elegant kind of net-work; polype with eight claws. See ZOOPHYTES.

GORTERIA, in botany, so named in honour of David de Gorter, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Capitatæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, with spiny scales; corolla of the ray ligulate; down woolly; receptacle naked. There are thirteen species, mostly shrubby plants from the Cape of Good Hope.

GOSHAWK, the English name of the yellow-legged falcon, with a brown back, and a white variegated breast. See FALCO.

GOSSAMER is the name of a fine filmy substance, like cobweb, which is seen to

float in the air in clear days in autumn, and is more observable in stubble-fields, and upon furze and other low bushes. This is probably formed by the flying-spider, which, in traversing the air for food, shoots out these threads from its anus, which are borne down by the dew, &c.

GOSSYPIUM, in botany, English *cotton,* a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double, outer trifid; capsule four-celled; seeds wrapped in cotton. There are six species. See MANUFACTURE *of Cotton.*

GOTHIC *style,* in architecture. The characteristics of this manner of building are pointed arches, greater height than breadth in the proportions, and profuse ornament chiefly derived from an imitation of the leaves and flowers of plants. The word gothic, by which it has long been distinguished in England, has lately been considered by its admirers as a term of reproach applied by architects, who were at a loss how to imitate its excellence, in order to bring it into disrepute, the former therefore now call it the pointed style. If we were to judge wholly from the complete oblivion which involves the origin of gothic architecture, it must follow that architects were held in as little estimation about the time of Henry III. as common masons are at present; but this inference is doubtful, and the cause that the names of the most eminent have not reached us may be more correctly attributed to the then and subsequent neglect of literature. Writing was almost exclusively confined to the cloister, yet the monks who could best inform us of their architects and the changes in their styles were unaccountably silent on the subject, an instance may be cited from Malcolm's "Londinium Redivivum," in which that author introduces a legend of the building of the priory of St. Bartholomew, Smithfield, written immediately after the death of Rahere the founder, by a monk resident there. This person describes the manner in which the money was raised, and many miracles performed, but not a word occurs relating to the architect: Rahere died in 1174, and the monk adds, "And with moor ampliant buildings were the skynnys of our tabernaculys dylatid;" we may therefore suppose that the arches under the tower which are partly circular in the Saxon style, and partly pointed, were some of the first essays in the new mode of building, and erected about 1200.

Westminster Abbey was begun by Henry III. in 1245, this beautiful edifice is a complete and regular specimen of the purest pointed style, it is consequently perfectly fair to suppose, that the interval between the above dates was the period when gothic architecture superseded its heavy and tasteless predecessor. That it soon became the favourite mode may be concluded from its adoption in all the additions made to old churches at that time, which is discoverable in an instant by the total disagreement of the proportions and ornaments. There is every probability that the first principles of the style in question were derived from the eastern nations, now partially under the dominion of the East India Company, where there are many buildings dedicated to their mode of worship that might almost be called gothic, and those are certainly very antient. The Romans had explored the coasts of those countries, and their remote descendants may have seen representations of the structures alluded to left by their ancestors and adopted them with alterations in some few of the earliest specimens of Christian churches. When a people of so much importance, in the history of the world, as the successors of its conquerors introduced any peculiarity in their manners or buildings it is reasonable to suppose that they were eagerly imitated throughout Europe; hence we find that a few centuries produced a vast number of churches, in the pointed style, in the Italian States, Germany, France, Spain, &c. &c. though it must be admitted that the latter country being conquered by the Moors, may have in some measure operated to introduce an imitation of their mosques, which are very like gothic architecture.

Such are the conjectures which naturally follow the consideration of this subject, and yet they may be altogether erroneous, as much might be said to induce a supposition that the pointed style was gradually invented by the abberration of the pencil and compasses, or similar instruments of ingenious architects, who having observed intersected arches in some very antient Roman buildings, of Grecian architecture, admired their effect and followed them as fundamental principles in new designs. This speculation may be supported by referring to an engraving by Marco Sadeler, representing the ruins of the Terme

di Diocletiano, which shews the perspective of a long passage very similar to the aile of a church, where the roof is made completely and decidedly gothic by the intersection of arches throughout.

Some enquirers as to the origin of the style, have thought that the first idea of high pointed ailes was taken from avenues of lofty trees, the branches of which interweaving suggested the rich ribs and tracery of the later specimens of the art, but this is mere conjecture and fancied resemblance.

One of the most plausible reasons for supposing the invention gradual, is the finding of interlaced arcades on the sides of Saxon buildings, intimating an inclination to deviate from the semicircle of that style. (See plate GOTHIC ARCHITECTURE, fig. 1.) The pointed arch, as has been mentioned, intermingled with the circular in the ribs or groins of the roof, and lastly occurred the plain and positive pointed manner, the earliest instances of which have very little decoration compared with the more modern; indeed the rapid increase of ornament may be traced in our numerous and magnificent cathedrals, till their introduction operated to render the gothic style too expensive for continuance.

That this taste was imported into England from the Continent will not admit of a doubt, but it is absurd to suppose that architects and masons were imported with it, as certain authors have imagined; it would be just as erroneous to say that because Somerset House has a general resemblance to continental palaces the architect and his masons came from thence.

It is impossible to treat this subject methodically, as the principles of the gothic are simply those mentioned at the commencement of the article; indeed the varieties and caprices often observable in the same building set all rules at defiance, and yet there are numbers of regular structures, the parts of which correspond exactly.

One of the arcades in the choir of Gloucester cathedral is seventeen feet wide, the columns on its sides are fifty-seven feet high, and the arch from the capitals to the point twenty-one feet; a circular arch, aperture, or window into another part of the church, in the same arcade, has the following proportions, width twelve feet, and the height fifteen feet. The west front of the same church has a great central window, and two lateral, those certainly should be of the same dimensions to preserve the necessary uniformity, but that is not the fact, one being sixteen feet wide and thirty-one high, and the other twenty-nine feet high and twelve wide.

Two segments of a circle meeting at the tops make the pointed arch, (see fig. 2.) to improve the nakedness of this figure, the inventors introduced the section of a quatrefoil, or figure formed of four leaves, within the arch, (see fig. 3.) and ribs or borders sometimes raised, and at others excavated; each of those were afterwards enriched by pierced tracery, see fig. 4.

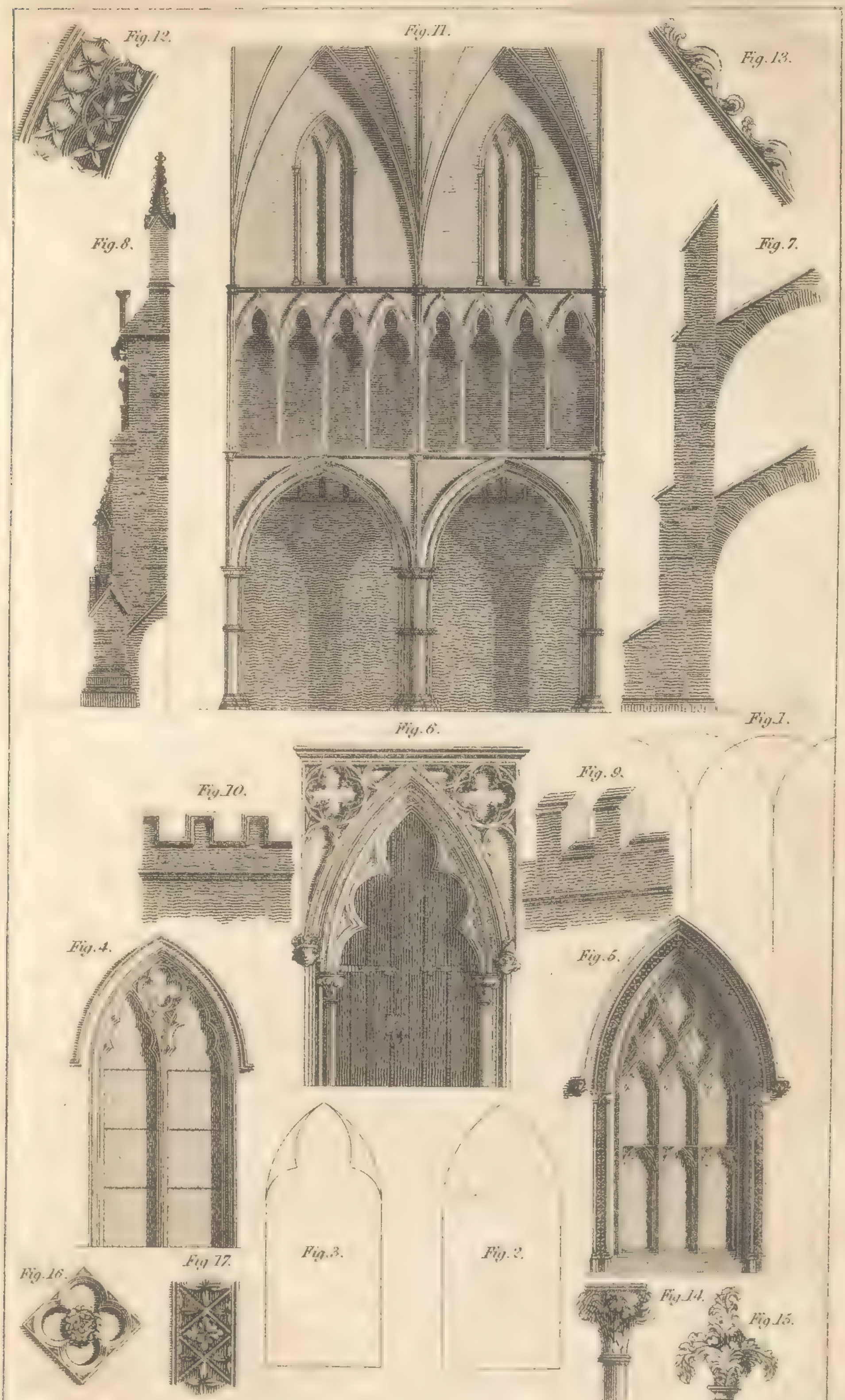
The windows were bounded by numerous pillars with beautiful capitals of foliage, and intersected by perpendicular and horizontal bars or mullions, the former of which turned into delicate ramifications and filled the arch, (see fig. 5.); painted glass rendered those extremely grand when viewed within the structure, mouldings or cornices almost universally divided the different ranges of windows, the doors of the casement nearly reach the lower, and the angles above the arch are adorned with tracery, see fig. 6.

The windows are separated by buttresses, which vary in breadth, depth and solidity, according to the fancy of the architect, and are frequently very magnificent, as they admit of being pierced into an arch, as (in fig. 7.), in order that they may contribute to the support of two walls on different lines, and are decorated with niches under fretted canopies, statues and pinnacles, see fig. 8.

Battlements extend along the summits of the walls, those are of different kinds, see fig. 9, 10.

The interior generally exhibits three ranges of arches in each arcade, the lowest are bounded by a strong pillar, with others more slender filleted round it; from the capitals of those arise the first arch, three of the small pillars ascend to the spring of the roof; the second range of arches open into a gallery, and the upper are windows (see fig. 11.) which exhibit the tracery or ribs from the pillars on the roof. Fig. 12, 13, 14, 15, 16, 17, shew a variety of ornaments peculiar to the gothic or pointed style of architecture.

GOUANIA, in botany, so called in honour of Antoine Gouan, M. D. a genus of the Polygamia Monoecia class and order. Natural order of Rhamni, Jussieu. Essential character: hermaphrodite, calyx five-



Malcolm delin

London, Published by Longman, Hurst Rees & Orme, 1809

cleft; corolla none; anthers five, under a veil; style three-cleft; fruit inferior, tripartite: male, similar, but without germ and stigma. There is only one species, *viz.* G. domingensis, chavstick, a native of St. Domingo in the woods.

GOVERNMENT, in general, is the polity of a state, or an orderly power constituted for the public good.

Civil government was instituted for the preservation and advancement of mens' civil interests, and for the better security of their lives, liberties, and properties. The use and necessity of government is such, that there never was an age or country without some sort of civil authority; but as men are seldom unanimous in the means of attaining their ends, so their difference in opinion, in relation to government, has produced a variety of forms of it. To enumerate them would be to recapitulate the history of the whole earth. But they may, in general, be reduced to one of these heads; either the civil authority is delegated to one or more, or else it is still reserved to the whole body of the people; whence arises the known distinction of government into monarchy, aristocracy, and democracy. See ARISTOCRACY, CONSTITUTION, DEMOCRACY, &c.

A mixed government is composed by the combination of the simple forms of government which have already been, or will hereafter be, described; and, in whatever proportion each form enters into the constitution of a government, in the same proportion may both the advantages and evils, which have been attributed to that form, be expected. The government of this country is unquestionably a mixed government, though by some writers it is denominated a limited monarchy. It is formed by a combination of the three regular species of government; the monarchy residing in the King, the aristocracy in the House of Peers, and the republic, being represented by the House of Commons. The perfection intended, and, with regard to the United Kingdoms, in a considerable degree effected, is to unite the advantages of the several simple forms, and to exclude the inconveniencies. "For, as with us," says Sir William Blackstone, "the executive power of the laws is lodged in a single person, they have all the advantages of strength and dispatch that are to be found in the most absolute monarchy; and as the legislature of the kingdom is entrusted to three distinct powers, entirely independent of each other: first, the King; secondly, the Lords, spiritual and temporal, which is an aristocratical assembly of persons selected for their piety, their birth, their wisdom, their valour, or their property; and, thirdly, the House of Commons, freely chosen by the people from among themselves, which makes it a kind of democracy; as this aggregate body, actuated by different springs, and attentive to different interests, composes the British Parliament, and has the supreme disposal of every thing; there can be no inconvenience attempted by either of the three branches, but will be withstood by one of the other two; each branch being armed with a negative power sufficient to repel any innovation which it shall think inexpedient or dangerous." See MONARCHY.

GOUGE, an instrument or tool used by divers artificers, being a sort of round hollow chissel for cutting holes, channels, grooves, &c. either in wood or stone.

GOUST, or GOUT, signifies taste or skill in poetry, painting, &c.

GOUT. See MEDICINE.

GRACE, in music, either in vocal or instrumental performances, consists not only in giving due place to the decorative additions, but in that easy, smooth, and natural expression of the passages, which best conveys the beauties of the composition, and forms one of the principal attributes of a good performer.

GRADUATE, a person who has taken a degree in the university. See DEGREE.

GRADUATION, in mathematics, the act of graduating or dividing any thing into degrees, or equal parts.

GRAFT, or GRAFF, in gardening, a scion or shoot of a tree inserted into another, so as to make it yield fruit of the same nature with that of the tree from whence the graft was taken. See GARDENING, BUDDING, &c.

GRACULA, the *grakle*, in natural history, a genus of birds of the order Picæ. Generic character: the bill convex, thick, sharp-edged, somewhat naked at the base; nostrils small, near the base of the bill; tongue entire, rather sharp at the end; claws hooked and sharp. No species of this bird is found in Europe. There are thirteen species, of which we shall notice the following: G. kelegiosa, or the minor grakle, is of the size of a blackbird, is found in various districts of the East Indies, and almost in every island beyond the Ganges. It is rendered familiar with the

greatest ease, and taught to speak with greater facility than even the parrot, and also enounces its words with more distinctness. It feeds on berries and fruits, and is particularly partial to cherries. When refused its wishes, it is stated to express sounds of disappointment and vexation extremely like the crying of a child.

The paradisœa tristis is rather larger than the former, and inhabits the Philippine Islands. It is exceedingly voracious, and has been known to swallow a young rat nearly two inches long, after beating it against the wires of its cage to soften it. It alights on the backs of oxen in its unconfined state, and devours the vermin which annoy them. These birds are particularly fond of grasshoppers, and are stated to have been imported into the Isle of Bourbon, purposely to extirpate those consuming insects which they have effectually accomplished. Being as they are, however, highly prolific birds, devouring every species of fruits and grain, and occasionally entering pigeon-houses and destroying the young, the inhabitants of the island have often found their depredations greater than those of the enemy which they were called in to extirpate.

G. quiscula, or the purple grakle, inhabits Carolina, and other parts of North America, and also the Island of Jamaica. It is a very considerable nuisance to the farmers of those countries, by scratching up the maize seed almost as soon as it is put into the ground. When the leaf appears, these purple daws, as they are called, will often tear up the plant by the roots; and when the maize is ripe they commit their depredations upon it in immense flocks, insomuch that premiums have been occasionally given for the destruction of them. They are, however, extremely serviceable by devouring insects. They pass the greatest part of the winter in swamps, overhung with woods; from which, on days of fine weather, they make their appearance abroad. Their flesh is far from being excellent, but their notes are melodious.

GRAIN, the name of a small weight, the twentieth part of a scruple in apothecaries weight, and the twenty-fourth of a pennyweight troy. See WEIGHT.

A grain-weight of gold-bullion is worth about two-pence, and that of silver half a farthing.

GRAIN also denotes the component particles of stones and metals, the veins of wood, &c. Hence cross-grained, or against the grain, is contrary to the fibres of wood, &c.

GRAINING *board*, among curriers, an instrument called also a pummel, used to give a grain to their leather. See CURRYING.

GRAMMAR. 1. The grammar of any language is a set of rules and observations, directing to the proper use of the sorts of words composing that language. These rules are founded upon the general usage of good writers; and after this is ascertained, it is customary for those who are desirous of speaking and writing correctly, to be uniformly guided by it. Grammarians, then, do not make a language; but they are formed by an enlightened view of the language, and afterwards direct the employment of it.

2. The art of grammar is sometimes divided into four parts: Orthography, Etymology, Syntax, and Prosody. The first and last of these have nothing to do with grammar, except so far as they relate to the grammatical changes made on different sorts of words. Etymology refers to the arrangements of the sorts of words, and to the various changes which are made upon them. Syntax directs the employment of those changes, and the situation of the different sorts of words in a sentence.

3. Hitherto grammar has been spoken of as an art, but it is in no way our intention to enlarge upon it in this view. Those who wish to study it in order to guide their use of the English language, we refer to Mr. Murray's "Grammar," and Dr. Crombie's work on "Etymology and Syntax;" and in the latter, many valuable remarks will be found, respecting scientific grammar. Considered as a science, grammar has for its object those principles on which its rules are founded. Scientific grammar discusses the grounds of the classification of words, and investigates the reasons of those procedures which the art of grammar lays down for our observance.

4. Grammar, as an art, refers only to particular languages; because it would be impossible to lay down any system of rules which would apply to two languages. We may point out in what respects the grammars of two languages agree; but we cannot form a common grammar for both. To a certain extent, the principles of scientific grammar are general, and some of them may be said to be universal. The laws of the human mind are the same in all ages, and in all nations; and of those causes which have

called forth its energies, many have operated universally. Whatever have been the variety of terms, and of the modification and arrangement of them, the grand objects of men, in the formation and extension of language, have been the same,—to communicate their sensations, their judgments, their reasonings; to express the objects of their thoughts, and the changes and connexions observed among them,—and, to do this with dispatch. This has produced great uniformity in the general principles of language. But the connexion between words and thoughts is arbitrary, as well as the mode of connecting words themselves. Hence, with much uniformity, we meet with much variety: and hence, universal or even general grammar, must be confined within very narrow limits, till the phenomena of a variety of languages have been examined, and their correspondence with each other, as well as their diversities, ascertained. For some of those more general principles which may be regarded as the foundation of language in general, we refer our readers to the articles LANGUAGE, and *the Origin of Alphabetical* WRITING: we shall here content ourselves with making the philosophy of our own language our principal object, though we may occasionally be led to state the more general principles of grammar, and derive our illustrations from other languages. Such a mode of procedure may contribute to render the practical use of our own language more clear and certain.

Of the Arrangement of Words.

5. The first object of scientific grammar, is to form an arrangement of the sorts of words composing a language. In languages which admit of various changes in the form of words to denote changes of meaning, the arrangement, in a great degree, is pointed out for the grammarian; and a technical classification will, in such cases, have a decided superiority over one founded purely upon scientific principles. In languages like our own, we are less shackled by the contrivances of art; yet our arrangements ought to have in view the advantage of practice.

6. The true principle of classification seems to be, not essential differences in the origin or signification of words, but the mode in which they are employed. It should, however, be steadily kept in view, that all distinctions among the sorts of words have gradually arisen out of the circumstances in which language has been formed, and proceeded towards maturity; and that such distinctions are by no means to be extended beyond the present employment of words. It is necessary, for convenience and dispatch, that we arrange; but arrangement must not supersede further examination. The fact is, that originally there could have been but one sort of words, the *names* of the objects of our sensations and ideas. From these all others must have sprung; but, without words expressing *affirmation*, language must have moved very slowly, and often have been very ambiguous; and therefore we may reasonably suppose, that the ever active principle of association would soon transform *nouns* into *verbs*, by making them in certain situations expressive of affirmation. From these two classes all the rest have sprung; and though it is desirable, and even necessary, for the grammarian to arrange, it should ever be carefully borne in mind, that his arrangements respect the present contrivances of language; and that he, who would look into the causes of these contrivances, must retrace the steps which have been trodden, and see what were the procedures of those periods when language was merely the child of necessity, not the organ of long-established and intricate associations. The philosophy of language is one branch of the philosophy of mind, and neither will be fully understood till both are.

7. The objects of sense and intellect are, in reality, nothing more than properties, or collections of properties. The mind, however, resorts to a support for those properties; something by which they are connected; in which they exist: and this we call *substance*. As far, however, as this word has any meaning, it signifies nothing more than *a collection of properties existing, or capable of existing, independently of other properties*. These properties may be considered *collectively;* or they may be thought and spoken of, though they cannot exist, *separately*. We can think of no material substance which does not possess, at least, two properties; no visible object, for instance, can be without colour and extension: but we can think of extension and of colour separately, that is, we can direct the attention of the mind to each of them exclusively, of the other properties with which it may be connected. This separate or exclusive attention of the mind is called *abstraction*. It is a very simple, though a very difficult operation of the mind. It is often confounded with *generalization;* but though

exercised in every act of generalization, it may be exercised altogether independently of it.

8. The *names* of substances are called *substantives;* the *names* of properties without reference to the substances of which they form a part, are called *abstract nouns.* To every name comprehended under these two classes, the term NOUN is applied. A noun is said to be increased or diminished in *comprehension*, when the *number of ideas* denoted by it is increased or diminished; and in *extension*, when the *number of objects*, to which it can be applied, is increased or diminished. Those single words, which are added to nouns to vary their comprehension, or to vary or determine their extension, are called ADNOUNS. From these similar, yet generally distinct objects of different adnouns, arise two grand classes, *adjectives and restrictives:* the former varying the comprehension of the conjoined nouns; the latter varying, sometimes determining, the extension of them. In one mode of the application of the term, adjectives are nouns; for they are the names of properties; and, as will be seen in LANGUAGE, originally they were nouns; but since they are not employed alone, like substantives and abstract nouns, to denote the objects of thought or discourse, it is preferable to class them with words whose use and employment is similar. Founding our arrangement on the use and mode of employment of words, we include, under the head of nouns, those words only which denote substances and properties, without being connected with other words. This, of course, includes substantives and abstract nouns; but excludes adjectives.

9. We constantly find it necessary to speak of ourselves, to address others, or to speak of others. If we wish to speak of ourselves, or to address others, we immediately find, that we must either mention the names of the individuals concerned, or use some words not belonging to ourselves or them, as individuals, but, as the persons speaking, or spoken to. How much to be preferred the latter method is, a slight attention to the subject will show: George might say to James, "George hopes that James is well, and that James will come and see George very soon:" but there is nothing in this which shews that George is the person speaking, or that James is the person spoken to; and besides, it often happens, that the names of the parties in conversation are mutually unknown. It is the mode adopted by children, and persons speaking to them; and probably was so universally in the early periods of language; but we feel that we want more. Suppose George to say, "The person speaking hopes the person spoken to is well, &c.; it would be perfectly intelligible, and answer every purpose but that of dispatch. That would be effected by using some short words of equivalent signification; such are *I* and *thou. I* has the same force as *the person speaking*, *thou* as *the person spoken to*; except that *I* and *thou* are limited to the individuals actually speaking or addressed, or supposed to be so speaking or addressed. These words are then, strictly speaking, *nouns;* but as they are used *for names* of persons, they are called PRONOUNS, that is, *for-nouns.* Again, suppose we wish to speak of some person or thing, which we have before mentioned, in such a manner as will denote, that we have before mentioned that person or thing, instead of merely repeating the word, as "James is gone, and James will come back;" in which case it is left to an inference, which, in many cases, would be a doubtful one, that the latter referred to the same person as the former,—we might say "James is gone, and the *said* James (or the *said* person) will come back," or, "and *he* will come back." Here it is obvious, that *he* not only supplies the place of the name, on which account it might be called a pronoun, but has a distinct reference to the person having been before mentioned. In a similar manner, *she* means the female person spoken of; and *it*, the thing spoken of. These words, with their plurals, are all called pronouns, and though they obviously either come under other sorts of words, or are abbreviations for one or more of them, yet they are at present so distinct and important in their use, that they require a separate class. PRONOUNS, then, are words used for the names of persons or things, connected with the idea, that they are either speaking, spoken to, or before spoken of.

10. We cannot advance one step in language, without leading our hearers or readers to the inference, that certain ideas are connected in our minds, or that we believe certain objects, properties, or events to be connected. The connecting link in language need not always be stated; in the infancy of language it could not exist, and in the language of childhood it does not exist. Words are joined together, and it is easily understood, that the corresponding

ideas are connected in the mind. "Mamma, milk good," would surely be understood by any one; and, in similar cases, depending upon the ease of inference, the ancient writers left it to the mind of the reader to form it for himself. But how slowly and how ambiguously communication would proceed, without some appropriated link of connection, any one may be convinced, by leaving out of a few sentences those words, which, in our language, serve that purpose, and which, in all languages, are necessary to render an affirmation complete. The intelligent reader, to whatever other account of such words he may have been accustomed, will perceive, that we refer to verbs. The essential quality of a VERB is, to express affirmation, when joined with the subject of the affirmation. Whenever a word expresses it, that word is a verb: if in any case it does not express it, it ceases to be a verb. That it does express affirmation is, doubtless, by an inference of the mind; in itself considered, it can only be the name of some quality or circumstance of its subject; but by being frequently employed with such inference, and, in the later periods of language, being invested with peculiarities of flexion, it acquires a character different, in appearance at least, from that of the noun, and, in many instances, is *appropriated* to convey the inference, that something is affirmed of its subject.

11. From verbs, or rather from the *noun-state* of verbs, in which they do not express affirmation, a new class of words is formed, partaking of the characteristics of the noun and adjective, and agreeing with verbs in the accidental circumstance of requiring after them a peculiar form of pronouns. These words are called PARTICIPLES.

12. In the same manner as it is found needful, for the purpose of accurate and expeditious communication, to employ words to modify or restrict the signification of nouns, it is found at least convenient to appropriate other words to modify or restrict the signification of adnouns and verbs. These are called ADVERBS, which are to be regarded as a class of words formed from nouns or adnouns, and used to express some quality or circumstance respecting the action, quality, or circumstance denoted by verbs or adnouns. They are therefore convenient abbreviations, which may be supplied by the other sorts of words.

13. From nouns, adnouns, and verbs, another class of words have arisen, which, from the long disuse of the original forms of them, have lost their peculiar characteristics, and are now regarded as independent of them. They are now used to connect words, or sentences, or words and sentences; and, in general, point out some particular kind of connexion. From the employment of them, they may be termed CONNECTIVES; and under this class, we comprehend those words which are usually denominated Prepositions and Conjunctions. The distinction between these two sorts of Connectives, is merely technical; the latter requiring after them a peculiar form of the pronoun, and of the noun, in languages in which the noun admits of flexion.

14. We feel obliged, very much against our inclination, to admit, as an eighth class of words, some of those which are usually denominated INTERJECTIONS. Words of this sort are of very little importance, and by many are thought undeserving of the name of words. Some are *involuntary* expressions of grief, or joy, or surprize, or some other strong emotion: and some may be used with the *intention* of informing others what emotions are in the mind of the speaker or writer. The former set have no more right to be called words, than the sigh of sorrow, the groan of pain, the laugh of mirth, &c., which no one calls words; for words are voluntary vocal sounds, employed to express our ideas to others. The latter set are generally found to be parts of sentences, or single words of the before mentioned sorts. Our great philosophical etymologist, Mr. Horne Tooke, has traced the origin of the greater part of them; and the few that remain, will probably be hereafter traced by some of those grammarians who are treading in his steps.

We now proceed to a few remarks on each of these sorts of words: our limits will allow of very little amplification, and will enable us only to present an outline to our readers. Those who wish for farther information, we beg to refer to the article GRAMMAR, in Dr. Rees's "Cyclopedia."

I. *Of the Noun.*

15. Those words which are *names* of things, and which can stand alone, as the subject of an affirmation, are called *Nouns:* this class of words has two grand divisions: *substantives* and *abstract nouns* (8.) *Substantives* are the names for substances. All names must originally have been names of individuals; the extension of the applica-

tion of them must, however, have been immediate. The difficulty of producing a great number of distinguishable articulate sounds, and the operation of the associative power, first led to generalization; convenience, perhaps we may justly say necessity, led to its extension and completion. When a number of things resemble each other in some striking particulars, we class them together in one species, and give to the species a name which is applicable to every individual included in it. When several species agree in some common properties, we refer them to a higher class, which we call a genus, and to the genus give a name which is applicable to every species and every individual included in it; and this classification we extend to the limits of human knowledge; and it is one of those admirable contrivances which are the result of necessity or of casual circumstances, but which, being extended and perfected by science, contribute essentially to the progress and diffusion of knowledge. But though it is necessary, for the purposes of communication, that many names should be applicable to classes of individuals, it is also necessary that there should be others capable of denoting individuals, without the circuitous plan of naming the general term, and the distinguishing qualities of the individual: and, accordingly, we find in all languages numerous words, which apply to an individual only, or, at least, are at once referred both by speaker and hearer, to an individual. Those names which, when alone, apply to a number of individuals, are called *general terms*, *appellatives*, or *common nouns*; and those which, when alone, are used to denote particular individuals, are called *proper nouns*. Sometimes proper nouns are so applied, as to become common nouns, as when we say, the Cæsars, or the Ptolemies. These are instances of the commencement of generalization; but there is another mode of the use of proper nouns, which is more illustrative of the processes actually adopted, in employing terms originally denoting an individual, to denote classes of individuals, who resemble him in some striking characteristics: thus, we say, "the Bacons, the Newtons, and the Lockes, of modern times," meaning, by these terms, all those individuals who have resembled Bacon, Newton, or Locke, respectively, in the mode and success of their investigation.

16. Though it seems to be a very simple procedure to form and appropriate names to denote properties separate from the other properties with which we see them connected in nature, the origin and appropriation of such names must have been very gradual; and the contrivances which, in the natural progress of language, have been adopted to designate separate properties, are among the most curious procedures of the art of mutual communication. Mr. H. Tooke, who has indisputably conducted us further towards an acquaintance with the causes of language than any other author on grammar, considers abstract terms as (generally speaking) "participles or adjectives used without any substantive to which they can be joined." "Such words," he observes (Epea Pteroenta, vol. ii. p. 17) "compose the bulk of every language. In English, those which are borrowed from the Latin, French, and Italian are easily recognized, because those languages are sufficiently familiar to us, and not so familiar as our own: those from the Greek are more striking; because more unusual: but those which are original in our own language have been almost wholly overlooked, and are quite unsuspected." A large proportion of the nouns which he thus traces, are certainly not to be considered as abstract terms, according to what appears to be the customary meaning of that appellation, (such as *view*, the past part of *voir*, something *seen*; *tent*, the past participle from *tendo*, something *stretched*:) and others certainly require more explanation than he has thought right to give, (for instance, *providence*, *prudence*, *innocence*, and all the rest of the tribe of qualities in *ence* and *ance*, which he considers as the neuter plurals of the present participles of *videre*, *nocere*, &c. without shewing us why *things foreseeing*, or *things not hurting*, have acquired the force of the above words:) but a considerable number of his derivations are very satisfactory, and give great insight into the procedures of language. A few may be adduced as a specimen of his etymologies. *Skill* is the past participle of the Anglo-Saxon verb ꞅcylan, *to divide*, *to make a difference*, *to discern*; and it signifies that faculty by which things are properly *divided* or *separated* one from another. *Sorrow* is the past participle of ꞅẏꞃƿan, to *vex*, to *cause mischief to*, and is the general name for any thing by which one is *vexed*, *grieved*, or *mischieved*. *Wrath* is the past participle of ẏꞃıðan, *to writhe*. *Heat* is the past participle of ƕǽtan, *to make hot*. *Doom* is the past participle of ꝺeman, *to judge*, *to decree*.

17. Another class of abstract nouns, *viz*.

those ending in *th*, have been traced to a very probable origin by Mr. H. Tooke: he considers them as the third persons singular of verbs. For instance; *truth* (anciently written *troweth*, *trowth*, *trouth*, and *troth*,) means, what one *troweth*, *i. e.* thinketh, or firmly believeth: *warmth* means that which *warmeth*: *strength* is that which *stringeth*, or maketh one *strong*. While, however, we agree so far with Mr. Tooke, we cannot go with him when he limits our acceptation of words to that in which they were first employed; and supposes that all the complicated, yet often definable associations, which the gradual progress of language and intellect has connected with words, are to be reduced to the standard of our forefathers. We cannot avoid expressing our belief, that he has either totally overlooked, or greatly neglected the influence of the principle of association, both in the formation of ideas, and in the connecting of them with words. It does not follow, that because the ideas connected with abstract terms are not what Mr. Locke supposed, that there are no ideas connected with them, but that they are merely contrivances of language. Several classes of abstract nouns are altogether passed over by Mr. H. Tooke; and we regret it, because he is eminently qualified to trace the origin of those terminations by which are formed the names of qualities considered as separate from those substances in which they exist. One class is formed by the addition of *ness* to the adjective, such as *whiteness*, *goodness*, &c. *Ness* is the Anglo Saxon naeꝩ, or neꝩe, signifying *nose*. It is also used for *promontory*; as in *Sheer-ness*, *Orford-ness*, the *Naze*, &c. Joined to the name of a quality, it denotes that the quality is a distinguishing feature of an object; it consequently holds it up as an object of separate attention.

18. We now proceed to those changes which are made in the form of nouns, to express a change of signification; and first we shall attend to *number*. In speaking of the objects of thought, we have constant occasion to speak of one or more of a kind; in every language therefore we may expect to find a variation in the form or adjuncts of nouns, to denote unity or plurality. To avoid the necessity of using such adjuncts, or rather in consequence of the coalescence of them with the nouns, owing to the frequent use of them in connection with the nouns, a change of form has taken place in most cultivated languages. The Hebrew plurals are generally formed by the addition of מ, *mem*, to the noun, probably because מ was the symbol of water, and denoted collection and plurality; and in that language the coalescence has actually taken place, and occasionally undergone some corruption. Among the Chinese the plural adjunct has not yet coalesced with the noun; and they generally denote the plural by the addition of *min* to the singular. Supposing the coalescence of plural adjuncts to have been the origin of the changes on nouns to denote plurality of meaning, it does not necessarily follow that all plural changes were thus formed. The change of form produced by such coalescence in some cases might suggest a corresponding change in others, though the change might not be exactly similar. Hence, could we trace some of the plural changes to art, as their earliest origin, it would weigh little against the general principle. We shall, however, almost universally find, that the extension of old procedures, rather than the invention of new ones, has been the cause of almost all even of the artificial changes in language. The reason is obvious: besides the greater ease to the innovator, it would be much more intelligible to those who are to adopt his innovation. Even the philosopher judges it more proper to follow the analogies of his language, than to deviate from them where he knows such deviation would be an improvement. Except as far as is dictated by custom, and that convenience on which the custom has been founded, there is no reason why the same word unchanged should not be applicable both where *one* and where *more* are meant: why, for instance, we should not say *two man*, as well as *one man*. The plural form may be applied to two, or two hundred, or any indefinite number; now is there in the nature of the thing a more marked distinction between one and two, than between two and two hundred? In fact, were we always able to join to the noun a numeral, or some other adnoun denoting number, a plural form would be unnecessary; but it is frequently desirable to denote plurality where the number is indeterminate, or unnecessary to be specified. The Chinese drop their plural adjunct when there is another word of plurality attached to the noun. We do not go upon the same principle; but there are cases in which we make no changes to denote plurality, as twenty *pound* of flour, thirty *sail* of ships, four *thousand*, &c. These instances, though contrary to the prevailing analogy of our language, certainly do not oppose the gene-

ral principles of language; and though the neglect of the plural termination in such cases is ungrammatical, it probably savours less of vulgarity to go thus far with the multitude, than of pedantry to quit the beaten track. There are other instances, however, in which the use of the same word both in a singular and plural acceptation is perfectly legitimate; we say one, or twenty, *deer*, *sheep*, or *swine*. If there must be a form for unity as distinguished from plurality, why not forms to denote two things, three things, &c.? There is no reason but in their inferior utility some languages have a form for duality; and by the Greeks this form was carried through their nouns, adnouns, pronouns, verbs, and participles. They had, however, no scruple in using the plural form for two things, and in making their duals agree with plurals. The fact is, the distinction between one and more than one is more useful than any farther distinction. The indefinite denotement of plurality is continually serviceable; and if we wish to specify the exact number, the addition of a numeral is a much more simple procedure than the burdening of language with a number of distinctions, which would seldom be useful, and never necessary.

19. In every department of knowledge we are concerned with individuals; and though for the purposes of communication general terms are not only convenient, but absolutely necessary, some contrivances are requisite to designate individuals, or less general classes of individuals. This is done by means of adnouns, or by stating some connection between what is denoted by the noun and some other substance or quality. The latter is accomplished by juxtaposition, by prepositions, or by equivalent changes in the word connected. The last is called inflection, and the word so changed is called a *case* of the noun. In English we have only one inflection of the noun, and two of the pronoun. Persons who think that the procedures of every language must be accommodated to the grammar of the Greek and Latin, strenuously contend for an equal number of cases with their's. If *case* mean a change in the word, to denote connection with other words, then the plan of our language cannot be accommodated to that of the Latin: if *of a man*, *to a man*, &c. be considered as cases, there is certainly no reason why the same appellation should not be given to every noun to which a preposition is prefixed, and then we shall have above thirty cases. It is fortunate for the speculator, that, in this and other instances, language will not bend to the contrivances of the technical grammarian: for his wish to reduce every process to an agreement with a standard which prejudice only can deem perfect would, if successful, materially increase the difficulties of grammatical investigation. The variation of our nouns is confined to the denotement of one relation, that of *property* or *possession;* and it is therefore with great propriety called the *possessive case*. The appellation *genitive case* is sometimes applied to it; but the force of the Greek and Latin genitive is to denote relation in general, though capable of specific application, and is exactly equivalent to a noun preceded by *of*. The possessive case of a noun is not equivalent to the noun preceded by *of*, except where the latter has the specific force of belonging to. It may in all cases be represented by *of*, with the noun following; but the latter mode of expression cannot in many instances be represented by the possessive case. The French, Spanish, and Italian languages have no cases of nouns: the German has changes to express what we denote by *of* and *to;* but these changes are not carried through all the nouns. The Latin and Greek languages have still more variations, which they carry through all their variable parts of speech, except the verbs. The arrangement of these variations is the work of art; and the appellations of *case*, or *fallen*, and *declension*, or *bending from*, appear to have gone upon this principle: the word from which the cases are formed was represented by a perpendicular line, and the cases by lines declining or falling from it. For the sake of convenience, the nominative and vocative are denominated cases; and from the above contrivance the nominative was termed the *upright* case, and the other cases were termed oblique. The *nominative* is the name itself. The *vocative*, or case of calling, has its origin in those changes in the pronunciation which arise from the mode of utterance in calling to a person: it is a corruption, or an abbreviation of the nominative. We have already spoken of the force of the *genitive;* we shall only add here, that we have in English one procedure exactly corresponding to it in force, though not so universally applied, *viz*. juxtaposition. This is a very simple and intelligible procedure. To connect the terms is a satisfactory expression of the connection of the things signified: and in this procedure, as in the genitive, the kind of connection is left to be

inferred; as in the expressions iron ore, iron chain, iron heat, China orange, house door, &c. The theoretical distinction between the *dative* and *accusative* does not appear to be clearly marked; but the general force of the former is to denote *acquisition*, and of the latter to designate the word as the *object* of the action of verbs and their derivatives. As to the *ablative*, there is scarcely room for doubt that it is merely a variation of the dative form, where indeed it has a form distinct from it. Probably, in consequence of the ellipsis of a preposition, this form has by degrees become the denotement of the cause, manner, or instrument of an action; and this is now the primary force of the case when unattended by prepositions. The changes which are made to denote connection have been formed by prefixing or affixing letters to the words themselves; and they might have been arbitrary, or gradually produced by the coalescence of words or abbreviations of words. The latter hypothesis is in every respect so very probable, that nothing seems requisite to prove it to have been the general procedure of language; but to shew that it has actually occurred in some instances. It has been for some time the prevailing opinion among philosophical philologists, and it has acquired great support from the discoveries of Mr. H. Tooke. He states it without any limit, in the following manner: "All those *common* terminations, in any language, of which all nouns or verbs in that language equally partake (under the notion of *declension* or *conjugation*) are themselves separate words, with distinct meanings; which are therefore added to the different nouns or verbs, because those additional meanings are intended to be added occasionally to all those nouns or verbs. These terminations are all explicable, and ought to be explained." In fact, the progress of the coalescence has been detected in some of the most refined instances of it; and in many cases to which system has not reached the coalescence is universally allowed. In the two principal cases of the Greek noun, in some at least of its forms of inflection, the origin of the change has been traced; and all the cases of the Hebrew noun are obviously formed by prefixing (instead of affixing, as in the Greek) significant words. The grammarian does not indeed allow that the changes of the Hebrew noun are cases; but such arbitrary distinctions serve only to render obscurity more obscure. In the French, *au* and *du* are indisputaby abbreviations of *á le* and *de le:* we can trace their corruption, and we are not obliged to suppose greater corruptions in more disputable instances. What is the origin of the possessive termination of our nouns is very uncertain. It is obviously the corresponding Anglo Saxon termination; but what is the origin of that? We may hope to receive light upon this point, when the third part of "Epea Pteroenta" is laid before the public.

20. *Gender* is a distinction of substantives, as denoting males or females, or neither. The names of males are said to be of the masculine gender; the names of females, of the feminine gender; and all other names are said to be of the neuter, that is, of neither gender. The purposes even of accurate communication do not in all cases require any denotement of gender, and accordingly we find many words which are common to both sexes. The English and the pure Persian appear to be the only languages which observe the natural distinction in the division of nouns. We denote difference of sex, either by a change of appellation, or by a change on the word itself, or by a significant adjunct. In addition to its greater philosophical accuracy, the procedure of our language enables us to mark with greater perspicuity and force the personification of inanimate substances or abstract qualities. In the earliest languages there is no distinction of gender further than into masculine and feminine, and the reason is obvious; for the principle of animation appears to the uncultivated mind to pervade all nature. In the more cultivated languages in which a third class is admitted, the arrangement seems to have been the work of art. The foundation was laid in the natural distinction of sex; by degrees those terminations which most frequently occurred in the respective divisions were made the characteristics of those divisions, and nouns of similar terminations were arranged under them, without respect to the original ground of distinction. We must not be surprized to find, that languages derived from those, in which the distinctions of nature had given way to the divisions of art, should leave nature altogether; and we accordingly find, that in those modern European languages which are derived from the Latin, gender is little more than a mere grammatical distinction of nouns into two classes, called masculine and feminine.

II. *Of the Adnoun.*

21. We apply the term *adnoun* to those single words which are added to nouns to vary their comprehension, or to vary or determine their extension. Those which affect the former object are called *adjectives;* those which effect the latter we call *restrictives.* It is not, perhaps, in all cases, easy to say to which of these classes an adnoun should be referred, because the two objects are not always distinguishable; but in general those which denote *qualities* are adjectives, and those which denote *situation, possession,* or *number* are restrictives.

22. The adjective is exactly equivalent to a noun connected with another noun by means of juxtaposition, or of a preposition, or of corresponding flexion. *E. g.* A *golden* cup is the same with a *gold* cup, or a cup *of gold;* a *prudent* man is the same as a man *of prudence,* or vir *prudentiæ.* It has been already observed, that the Greek and Latin genitive, our preposition *of,* and juxtaposition, are all equivalent procedures, though custom has produced a variety in the mode of their application: we now add, that the adjective is another equivalent; and further, that the connection denoted by the adjective is equally indefinite with the others. *E. g.* A *healthy* colour is a colour *caused by* health; a *healthy* exercise is exercise *causing* health. And the use of all these procedures is the same, to particularize the general term, by connecting with the qualities which are included under it some quality which the general term does not include. In many instances, to denote that the name of a quality is used thus in connection with some other name, that is, in fact, that it is used as an adjective, certain terminations are employed significant of such connexion; and Mr. H. Tooke informs us, that those by which the simple adjectives are formed, *viz. en, ed,* and *ig* (our modern *y*) convey, all three, the designation that the names to which they are annexed are to be joined to some other names; and this by their own intrinsic meaning, for they signify *give, add, join.* "So the adjectives *wooden* and *woollen,*" he continues, "convey precisely the same ideas, are the names of the same things, denote the same substances, as the substantives *wood* and *wool*: and the termination *en* only puts them in a condition to be joined to some other substances, or rather gives us notice to expect some other substances to which they are to be joined."

23. Most languages which admit of inflection carry it through their adjectives as well as nouns. In some, the adjective is varied to express difference in the gender, number, and case of the connected noun. Where great liberty of inversion is desirable, these variations are convenient, because they point out with what noun the adjective is connected: where juxtaposition ascertains this they are unnecessary, since they make no change in the signification of the adjective. The signification of the adjective *wise, e. g.* is unchanged, whether it be applied to one man or woman, or to twenty men or women; whether its substantive be stated singly, or conjoined with others, as the names of the parents, place of abode, &c. of those to whom it is applied. The French always place the adjective close to its noun, yet they make changes on it to denote the gender of the connected noun. This is always unnecessary; but sometimes it contributes to elegance, by preventing an aukward circumlocution.

24. The qualities denoted by adjectives, may, in general, vary in degree: some, as dimensions and weight, may be measured with accuracy; and the comparative degree of some qualities, at least of heat and cold, can be ascertained with precision. Many, however, are incapable of exact measurement; and the cases in which the exact degree of the quality cannot be ascertained, are few in comparison with those in which it is unnecessary. When we use terms to express a greater or less degree of a quality, we may either make a direct and particular reference to the degree in which it is possessed by other objects, or use them without such reference. In the former case, we are said to compare the qualities; and variations of the adjective, to express this comparison, are called *degrees of comparison.* The difference between the comparative and superlative in our language, consists in the manner of construction merely, and not in the degree of the quality: thus, Solomon was *wiser* than any other king of Israel, is the same as, "Solomon was the *wisest* of the kings of Israel." The comparative is used, when we speak of an object as distinct from those with which we compare it; the superlative, when it is spoken of as one of those with which we compare it. Man is the noblest of animals, but not the noblest of the brute creation, otherwise he must be one of the brute creation: he is nobler than the brutes, but not than all animals, or he must be nobler

than himself. The custom of our language makes one distinction between the comparative and superlative, which does not coincide with this grand distinction. We use the comparative with the force of the superlative when we speak of two; as, he is the *wiser* of the two, and the *wisest* of any greater number. This is not an unjustifiable usage; but it has no particular foundation in the force of the comparative and superlative.

Few of the modern European languages vary the words themselves to express comparison. The French, *e. g.* express by *plus* and *le plus*, what we express by *more* and *most;* or (what is obviously equivalent, though custom limits their use to particular cases) by the terminations *er* and *est*. What is the meaning of these terminations? is a natural question: the answer is not so easy. It appears, however, very probable, that *er* is nothing more or less than the word which we still use in the form *ere*, signifying *before;* and, that *wiser* signifies *wise before.* Now, as has been well remarked by Mr. Dalton, *then* and *than* are the same in origin and signification: hence, *wiser than I,* is exactly represented by, *wise before then I, i. e.* wise before, then (that is, next in order) *I.* This derivation, if correct, explains the ground of the peculiarity above-stated, in the use of the comparative: he is the *wiser* of the two, means simply, he is wise before (the other) of the two. It might be conjectured, that the superlative termination *est*, is an abbreviation of *most* annexed to an adjective, in the same manner as in *topmost*, *undermost*, &c.; but Mr. H. Tooke has shewn, that *more* is merely *mo-er*, and *most*, *mo-est*, which leaves the origin of the terminations *er* and *est* as it was found.

25. Those adnouns which, without expressing qualities, vary or determine the extent of the signification of the nouns to which they belong, we call *restrictives.* Some restrictives are, by the custom of our language, applicable to singular nouns only; as *one*, *a* or *an*, *another*, *this*, *that*, *each*, *every*, &c.: others to plural nouns only; as *two*, *three*, *these*, *those*, *other*, *few*, *all*, &c.; but most restrictives, like all adjectives, are applicable to both singular and plural nouns. Of the restrictives, two are called *articles*, *the* and *an*, which last is abbreviated into *a* before consonants, *h* when pronounced, *u* long as in *use*, and *one.* *An* is simply another form of the numeral *one*, still used in North Britain under the form *ane;* and in the French, the numeral and the article corresponding to *one*, are the same. But though *an* and *one* have the same origin and primary signification, there is occasionally an obvious difference in the mode of their employment. This difference is well expressed by Dr. Crombie: "If, instead of saying, 'A horse, a horse, a kingdom for a horse,' I should say, 'One horse, one horse, one kingdom for one horse,' the sentiment, I conceive, would not be strictly the same. In both expressions, the species is named, and in both, one of that species is demanded; but with this difference, that, in the former, the name of the species is the emphatic word, and it opposes that species to every other; in the latter, unity of object seems the leading idea." *An* is called the *indefinite* article, because it leaves undetermined what one individual is meant; *the* determines the application of the noun to some particular individual, and hence it is termed, the *definite* article. It has the same primary signification with *that*; but they vary in the mode of their employment, the former never being employed without a noun, the latter having its noun frequently understood; and farther, *that* is more emphatic than *the:* these, however, are the refinements of language, and have no foundation in the origin of words. Mr. H. Tooke considers *that* as the past participle, and *the* as the imperative mood, of the verb ÞEAN *to get, to take, to assume;* and *the*, he observes, may very well supply the place of the corresponding Anglo-Saxon article ꞅe, which is the imperative of ꞅeon *to see;* for it answers the same purpose in discourse to say, *see* man, or *take* man. We really like the import of our forefathers' article so much better than that of our own, that we shall cheerfully give up *the* for *se*, unless it should appear, that *the* and *that* have their origin in some verb signifying *to point at.* Of that large class of restrictives called *numerals*, the origin of some may be traced; and as we wish to give our readers some insight into the labours of Mr. H. Tooke, we shall mention his derivation of words in this class. It is in the highest degree probable, that all numeration was originally performed by the fingers, the actual resort of the ignorant; for the number of the fingers is still the utmost extent of numeration. The hands doubled, closed, or shut in, may therefore well be denominated *ten* (the past participle of tynan to enclose, to shut in), for therein you have closed all numeration; and if you want more, you must begin again,

ten and one, *ten* and two, &c., to *twaintens*, when you must begin again as before. *Score* is the past participle of ꞅcıꞃan to shear, to separate; and means *separated* parcels or talleys. The ordinal numbers, as they are called, are formed like the abstract nouns in *eth*; *fifth*, *sixth*, *tenth*, &c. is the unit which *fiv-eth*, *six-eth*, *ten-eth*, *i.e.* makes up the number *five*, *six*, *ten*, &c. The ordinal numerals are obviously abbreviations of expression, for one, and one, and one, &c.; and we need not be surprised, as they are continually used, and were so originally, without any noun following them, to find them occasionally receiving the variations of the noun.

III. *Of the Pronoun.*

26. So much has already been said respecting the force of the pronoun, that it is unnecessary to enlarge upon it here. Mr. H. Tooke's derivation of *it* must however be stated, as it shews what have been the actual procedures of language in the formation of one of our pronouns, and gives an insight into the probable origin of the rest. *It*, formerly written *hit* and *het*, is the past participle of the verb **hatan** *to name*, and therefore means the person or persons, thing or things *named*, or afore-*said:* and accordingly was applied by all our old writers indifferently to plural and to singular nouns. We do not know whether a similar opinion, as to the origin of pronouns, has been before laid before the public, but the philosophical Greek professor of Glasgow, (whose prelections have often anticipated Mr. H. Tooke) long ago delivered it as his opinion, that some, at least, of the pronouns are participles; and, if we mistake not, traced the origin of εγω, and *ipse*, as follows. Εγω, in the more ancient dialect of Greece, was εγων, which is an obvious abbreviation or corruption of λεγων; so that εγω (whence the Latin and other languages have their first person) signifies the *speaking* person. *Ipse* is the Latin past participle from επω; and though this verb is not to be found in Latin writers, those who know how much the Latin is a dialect of the Greek, will not feel this a material difficulty: on this derivation *ipse* signifies the *said* person, &c. These speculations might be advantageously extended, would our limits permit; but sufficient has been said to show, that these words are not of that unintelligible nature which has been usually supposed.

27. Respecting the inflection of pronouns, the same general principles are applicable, as respecting that of nouns. *His* is obviously *he's;* and whatever be the origin of the possessive termination of the noun, it has the same origin here. *Mine*, *thine*, and *hern* and *theirn* still retained in some of our dialects, have apparently the same origin as *wooden*, *woollen*, &c. The objective form is merely a grammatical appropriation of one of the forms of the pronouns, to a particular purpose; and we still find that *her*, among the vulgar, is commonly employed as the subject of verbs instead of *she*.

28. Though we see no reason to give the appellation *pronoun* to those words which are called *adjective pronouns*, (and accordingly we class them as restrictives), yet there is one word of peculiar importance, which seems properly a pronoun, and to which some attention is necessary; *viz.* the *relative*. We have already observed several of the contrivances of language to particularize general terms; another is, to restrict or explain the general term by means of a dependent sentence connected with it by a relative. We will first consider what the relative performs, and then how it performs it. Take the following examples; every man, who loves truth, abhors falsehood; and John, who loves truth, hates falsehood. If the relative clause had been omitted in the former sentence, the remaining assertion would have been false; here then it is restrictive: in the second it is merely explanatory, and in such cases, so far from being necessary, may even destroy the unity and force of the sentence. To explain the subject of discourse, and to restrict its signification, are the two offices of the relative. If the custom of language allowed it, precisely the same purpose might be answered by an adjective or participle connected with the term, as, every man loving truth, &c. and it might seem useless to introduce a new procedure; but the utility of the present plan is obvious, when we consider the immense number of new words which must be introduced to supply the place of the relative, and further that it enables us to state a greater variety of circumstances in connection with the antecedent, and occasionally to state them more forcibly. The relative is equivalent to a personal pronoun with a connective of general signification. We do not mean to affirm that in the original signification that connective will be found;

but that such is the present force. The dependent clause may be joined to the principal, either by simple juxtaposition, or by means of a connecting particle, or lastly by a word including the force of a connective particle. Instances of the first are, The ship he commanded was wrecked, and, The man that (i. e. that man) loves wisdom shall find her: in both of which the dependent clause is connected in that natural manner which is frequently adopted in our simple language to express connexion in ideas; and in the same manner the early Greek writers employ their definite article for their relative. As an instance of the second kind we may adduce this mode of expression; A man if he do not love truth cannot be virtuous: in which the dependent clause is joined by a connective, though of a less general kind than what is implied in the relative. This last mode is the most general, and on the whole the most useful, because most general and least ambiguous. Without venturing to assert that *who* essentially differs in its original signification from *that*, it certainly does now include more signification; and that additional signification we think to be what is expressed by *and*, so that, Every man who loves truth hates falsehood, means, Every man *and he* loves truth, hates falsehood, *i. e.* as Mr. H. Tooke has shewn us, Every man *add* (this circumstance) *he* loves truth, &c.

IV. *Of the Verb.*

29. As we do not profess to consider the theory of grammar in general, we have not much occasion to enlarge respecting this important sort of words; for our language, simple in most of its procedures, is here almost at the verge of simplicity. Some languages have a great variety of changes in the form of the verb to denote the subject of affirmation, and the mode and time in which the affirmation is to be taken: we have only four, and of those three are to say the least in no way necessary. We have already said enough respecting the nature of the verb (§ 10.) to render it unnecessary to recur again to that point, and we shall here direct the attention of our readers to the modes of signification assumed by the English verb: only repeating, that the *verb* is a word which when preceded by a noun or pronoun, or by what may be represented by it expresses affirmation. In English and in other languages, words appropriated to express affirmation are often used without any such force: in such cases it might in some respects be more scientific to cease to give them the appellation of verbs, but it would be inconvenient in practice, and we prefer speaking of them as in the *noun-state* of the verb; so in the expressions, Eat this, and He dares not eat it, *eat* is in the noun-state.

30. To denote that a name was appropriated to be used as a verb, our ancestors added a distinguishing termination, like all other common terminations, almost certainly significant in its original state. Why that was dropped does not appear: but since it was dropped the verb in many instances ceases to have any thing in its form to distinguish it from the noun, and in a great variety of instances it is used exactly as a noun. It is true, it is generally, when in the noun-state preceded by the particle *to;* but in most instances *to* is used in its most customary sense, and in the few instances in which it seems to have merely the force of the Anglo-Saxon termination, it has a sense equally accordant with the original force of the word. Mr. H. Tooke has shewn that *to* (as well as *do* which is certainly the same word), is a particle of a gothic substantive signifying *act, effect,* and we presume *object;* now when we say, I am going to walk, *to* shows that *walk* (which is still the *name* of an action) is the object of my going: but when we say, To walk is healthful, *to* designates the word following as the name of an action, and the expression means, the *act* (*viz.*) *walk* is healthful. We must however admit, that the *use* of *to* before the noun-state of verbs, does not seem to be in every case consistent with its meaning; but such cases may fairly be referred to the general tendency there is to lose sight of the original force of words, in the stress laid on them in particular cases, or in the mode of their employment in particular cases; and hence by degrees to extend the employment of them to similar cases without reference to their primary signification.

31. The *infinite* mood, as it is commonly called, is the verb, divested of its peculiar force, *viz.* of affirmation, and uncompounded with those words which render it expressive of person, number, &c. and in the modern languages of time; but it seems erroneous to consider this as the fundamental form of the verb, where it has any distinguishing termination: it is then the noun-state of the word with a termination added to it, to show that it is to be employed as a verb. Thus in the Anglo-Saxon

ðean, ðe is the fundamental form of the verb, and AN is the verbalising adjunct. Now as the *imperative* form of the verb, is nothing more or less than the simple verbal name unattended with the inference of affirmation, this may be considered as the fundamental form : and in the Latin, in particular, the variations of flexion are traced with the greatest advantage from this source. But without enlarging on this point, with which our language in the present state of it has no concern, we must repeat, that the imperative form of the verb is merely the noun-state, or verbal name; and that command, entreaty, &c. supposed to be conveyed by it are merely the inference of custom. If I say to a servant, Bread, it is understood that I wish him to bring me bread, but it is not said: if I say, Bring some bread, in like manner it is understood, that I wish him to bring me bread, but all that is expressed, is the name of the action, and the object of the action. It has, indeed, been supposed, that an affirmation is understood, as, I desire you to bring some bread; but this supposition is rather to show, that *bring*, &c., in such situations, are verbs, than to show the actual procedure. The fact is, full as much is done by inference, as by actual expression, in every branch of language, and even as it is, thought is too quick for words. Admitting the justness of this account of the imperative mood we need not be surprised at the plan adopted by the Greek writers, of using the infinitive instead of it; nor need we resort to a sub-auditur, in order to show the ground of this use, or to complete the grammatical construction. And it may be considered as confirmatory of it, that the Hebrew imperative is the same with the radical form of the verb in its several conjugations, excepting Niphal, where it is the same as the infinitive.

32. When the verbal energy is referred to past time, a change is made in the form of nearly all our English verbs: the greater proportion of them add *ed* to the noun state. Whether this alteration was originally intended to refer the meaning of the verb to past time, or that the change had a different object, and the reference has been gradually formed in consequence of an appropriation similar to what we spoke of respecting the objective form of pronouns we have yet to learn; but there seems little room to doubt but that all the common changes which have taken place in the verbs of all languages, whether to denote time, person, number, or mode of signification, have been formed in consequence of the coalescence of words of appropriate signification; and though the gradual refinements of language may have greatly varied the associations of words from what they originally possessed, yet that these changes were originally found sufficient to answer their respective purposes. In some cases the contrivances adopted can be traced even yet; and from the new turn which has lately been given to etymological investigation, we may expect other discoveries respecting the causes or origin of particular flexions: the future of the French verb is nothing more than the infinitive of the verb, with the present tense of *avoir* following it; thus, *blâmer-ai* is *ai blâmer*, and *je blâmerai* means *I have to blame*, which mode of expression is in our own language used with a future force: the leading distinction between the past and future tense of the Hebrew verb is, that in the former the verb is placed before the fragment of the pronoun forming the person, and in the latter after it, as one would suppose to indicate that the verbal denotement is in one case past, in the other case future.

33. Similar observations may be made respecting the persons of verbs. In the Hebrew they are formed, as one would expect, by the coalescence of syllables, which are still acknowledged as pronouns: the same plan has doubtless been adopted in the Latin and Greek verbs, and in some few cases it can be traced with much probability. In our own language there are additions made to the verb, in both the past and present form, when *thou* is the subject of affirmation, and in the present, when any singular word excepting *I* and *thou* is the subject. We are not aware of any advantage derived from these changes (and the same remark may be applied to the French verb;) for they do not supersede the necessity of expressing the subject of affirmation, as in the case of the Latin and Greek verbs; but probably in their original import they contained in them the subject of affirmation, unless indeed they were different dialects of the verb, which by degrees were appropriated to particular subjects.

34. The variations in the Greek and Latin verbs, which denote time and manner of signification, are supplied in English by other verbs, which, from their employment, are called auxiliary, or helping verbs: these are *be*, *do*, *have*, *shall*, *will*, *may*, and *can*, which admit of the variations of other verbs,

and *must* and *let*, which are unvaried. *Do* in its present use is merely emphatic; and assists in producing a discrimination which cannot be denoted in other languages; but from its general resemblance to the other auxiliaries we have mentioned it among them. It is obviously the same word, both in appearance and in force, with the word *do*, when not employed as an auxiliary. *Shall* signifies *owe*, and was formerly used as a simple verb. *Will* we use at present as a simple verb. These two words are employed as the principal denotements of future time; and though their original signification has in some degree yielded to that with which custom has invested them, the former is usually to be traced. *May* signifies to be *able*. *Can* signifies to *know*, to *ken*, and thence to be *able*. These words are all employed as auxiliaries, in their past as well as present tenses. *Must* signifies to be *obliged*. *Let* is the noun-state imperative of to *let*, signifying to *permit*. *Have* as an auxiliary has the same force with the simple verb; it means to possess. How this meaning is preserved in the complex expression *I have loved*, or similar cases, we shall see in what will be said respecting the participle.

35. We have an abbreviated mode of expression in English, which has given some trouble to the grammarian, but is now pretty well understood, the *subjunctive mode*, or *future contingent form*. This arises from the omission of the future auxiliary *shall* or *will* after words which render the affirmation contingent: thus, instead of saying, *If thou shalt or shouldst love*, we may say, *If thou love*. In all other cases in which affirmation is made, we say the verb is in the *indicative* mood. On this mood we have only to make one remark, respecting the interrogative employment of it. In interrogations we may simply state the thing, or the assertion respecting which we require information, leaving our wishes to be inferred by the reader from the connection, or some word or mark of interrogation, or by the hearer from a variation in our tone; or, which is certainly preferable, we may make such a change in the order of the words as may leave our meaning out of doubt. This is effected in our own language by putting the subject after the verb; but this is not to be considered as making any change on the mode of its signification, but merely as indicating to the eye or ear the wish of the speaker to gain information respecting the affirmation.

V. *Of the Participle.*

36. Participles are formed from verbs, generally by the addition of terminations, originally without doubt expressive, but now ceasing to have in themselves considered any force. What their original force was will probably be shown us in future conversations at Purley; their present force is all into which we can as yet enter. Those participles which are formed by the addition of *ing* to the noun-state of the verb, express a *continued state* of the verbal denotement; and as it is frequently implied that what is meant by the verb is being continued at sometime referred to, they are called *present* participles. Those which are formed by the addition of *ed* or *en* to the noun-state, or by some change in the characteristic letters of the verb, usually denote the *completed state* of what is meant by the verb: hence they are called *perfect* participles, or sometimes, with less propriety, *past* or *passive* participles. There does not seem to be any material difficulty attending the employment of these words, except in the case where a perfect participle is employed after the verb *have*, as, I *have learned* my lesson. It has been supposed that this means, *I possess the finished act of learning my lesson;* we think it more probable that it means, I possess my lesson in that state which is called learned; in which case it is exactly equivalent to the Latin *habere*, followed by a participle in agreement with a noun. We readily admit that by, I have learned it, there is an inference brought into view which is not by, I have it learned; but it seems to be merely the inference of custom, not resulting from any essential difference in the mode of expression.

VI. *Of the Adverb.*

37. We have already given a general account of the class of words called adverbs. Those to which our definition will apply, and to which alone the term should be appropriated, are principally adnouns with or without nouns connected with them; others are prepositions with nouns following them; and the remainder are participles. The chief class of adverbs are those which end in *ly;* which termination is an abbreviation of the adnoun now spelt *like*, which is still frequently used by our northern neighbours as we use *ly*; thus, for *wisely*, they say *wiselike*. Of this class, a large proportion are formed by adding *ly* to *adnouns;* another set by adding the termi-

nation to *nouns*, as *manly*, *early* (from aeр, morning) &c.; and these last are also used as adnouns. *Abed*, *aboard*, *ashore*, &c.; and *perchance*, *perhaps*, are prepositions with nouns; *a* signifying *on*, *in*, or *at*, and *per* being the Latin preposition. *Why*, *how*, &c. seem to be restrictives, their nouns being understood; as, *why* signifying *what*, *cause* or *reason* being understood; *how* signifying *which*, *way* or manner being understood. Several adverbs besides those before-mentioned ending in *ly*, are used either as adnouns or adverbs; such as *well*, *ill*, *much*, *worse*, *better*, &c.; in all such cases it must be remembered that not the manner of signification, but merely the manner of employment, is changed. On the origin of most of those adverbs which are less obviously formed from other sorts of words, Mr. H. Tooke has thrown great light; some of his derivations we may briefly state, but our limits will not allow of our doing more. The following are past participles of Anglo-Saxon verbs: *ago* signifying *gone* (time); *adrift* signifies *driven*; *asunder* means *separated*; *fain*, *rejoiced*; *lief*, *beloved*; *astray*, *strayed* or *scattered*. *Needs* is *need-is*, used parenthetically. *Belike* is *by lykke*, *by chance*. *Aloft* is *on* or *in lyft*, *i. e.* the air, clouds, &c. *Much* is from *mo*, a heap; and is merely the diminutive of this word; passing through the gradual changes of *mokel*, *mykel*, *mochil*, *muchel* (still used in Scotland), *moche*, *much*. *Rather* is the comparative of *rath*, *swift*. *Quickly* is *quicklike*, cpıc, a past participle signifying *enlivened*; and it means in a *lifelike* or *lively* manner. *Very* is merely the French adjective *vrai*, anciently written *veray*, from the Latin *verus*. Some words usually classed with adverbs, seem to have no common link of union with the genuine adverb; such are *yes*, *aye*, *yea*, and *no*: indeed Mr. H. Tooke speaks of this class of words as the common sink and repository of all heterogeneous, unknown corruptions. *Aye*, or *yea*, is the imperative of a verb of northern extraction, and means *have it*; and *yes* is *ay-es*, *have that*. *Not* (a genuine adverb) and *no*, its derivative, have their origin in the word from which arise the Dutch *noode*, *node*, *no*, meaning *averse*, *unwilling*.

VII. *Of the Connective.*

39. The precise nature of the words usually denominated conjunctions and prepositions, was very little known, and not generally even suspected, till the publication of the "Diversions of Purley:" since that time, though philologists do not seem willing to admit, in all cases, the correctness of Mr. H. Tooke's derivations, yet his general principle is, we suppose, universally considered as completely established. Before his discoveries, it was the common opinion respecting the conjunction, that it is "a part of speech void of signification itself, but so formed as to help signification, by making two or more significant sentences to be one significant sentence;" and respecting the preposition, that it is "a part of speech, devoid itself of signification, but so formed as to unite two words that are significant, and that refuse to coalesce or unite of themselves." Our limits will not allow us to enter here into the arguments against these definitions, and the doctrine on which they are founded, nor indeed is it necessary; for, like the doctrine of instincts in mental philosophy, it solely depends on an appeal to ignorance, and falls to the ground when a probable account is given of those procedures which it is supposed to explain. The distinction between prepositions and conjunctions we consider as merely technical, referring to the grammatical usage of employing the objective form of pronouns after the former, and not after the latter, unless there be some word understood which requires it: for it will be obvious to any one that some conjunctions are still used "to unite words" as well as sentences, and that some prepositions are still used to unite sentences. The general principle before referred to is, "that all those words which are usually termed conjunctions or prepositions, are the abbreviations or corruptions of nouns or verbs, and are still employed with a sense (directly) referable to that which they bore when in the acknowledged form of nouns or verbs." We believe this to be a correct statement of Mr. Tooke's theory; to adapt it to our own arrangements we must include our adjectives under the term nouns, and our participles under the term verbs: and in addition to this remark, which is merely verbal, we must add, that in some instances this great philologist appears to have too much overlooked a procedure which meets us in various stages of language, *viz.* that among the ideas connected with a word, that which was originally of primary importance, becomes, by accidental circumstances in the mode of application, secondary only, and sometimes by degrees is altogether lost from the view

of the mind, giving place to others with which, from some cause or other, the word has been associated.

40. We now proceed to lay before our readers some specimens of the derivations and explanations given by Mr. H. Tooke. *That* is frequently termed a conjunction; it is sometimes termed a pronoun; we class it with the retrictives: but under whatever name it is known, its use and signification is the same. The differences supposed to be perceived in them arise simply from unnoticed ellipses or abbreviations of construction. If it be remembered that *that* was originally applicable to nouns of both numbers, no difficulty will be found by any intelligent reader in analysing sentences in which it occurs as a pronoun: in cases where it is used as a conjunction, the following analyses will serve as a sufficient clue. "I wish you to believe that I would not hurt a fly." Resolution; I would not hurt a fly, I wish you to believe that (assertion.) "Thieves rise by night that they may cut men's throats." Resolution; Thieves may cut men's throats, (for) that (purpose) they rise by night. *If* (formerly written *gif*) is merely the imperative of the Gothic and Anglo Saxon verb *gifan* to give. In Scotland and the northern counties of England *gin* is used in place of *if;* and *gin* is merely the past participle *given* abbreviated. Hence "I will read *if* (or *gin*) you will listen, means, *give* (or this *given*) that you will listen, I will read: and it cannot be unknown to the classical reader that the imperative *da* is used in exactly the same manner. *An*, now nearly obsolete, is the imp. of *anan* to grant. *Unless* (formerly sometimes written *onles*) is the imp. of *onlesan*, to send away. From *alesan* comes the imperative *else;* and from *lesan* the past participle *lest;* both verbs meaning the same with *onlesan*. From the same source come *less* and *least*, the privative termination *less*, the verbs *loosen*, *lose*, *lessen*, &c. *Yet* is the imperative of *getan*, to get; and *still*, of *stillan*, to put. *Though* (in some counties still pronounced *thaf*, *thof*), is the imperative of *thafian*, to allow or grant. *But* is now corruptly employed for two words, *bot* and *but: bot* is the imperative of *botan*, to *boot*, to add in order to supply a deficiency; *but*, of *beon-utan*, to be-out, and has the same signification as *without*. But properly requires a negative in construction with it, as I saw none but him; but it is often omitted, as, I saw but two plants. *Without* is the imp. of *wyrthan-utan*, to be-out. And is the imp. of *anan-ad*, to heap, or add. Formerly four different sets of words were used where now *since* is used, and it is now taken four ways: 1. For *siththan*, *sithence*, or *seen and thenceforwards;* as, It has not been done since the reign of John. 2. For *syne, sene, or seen;* as, Did George II. live before or since that example. 3. For *seand*, *seeing*, *seeing as*, or *seeing that;* as, I should labour for truth since no effort is lost. 4. For *siththe*, *sith*, *seen-as*, or *seen-that*; as, Since death in the end takes from all. *Sithence* and *sith* were in good use till the time of the Stuarts. *So* and *as* are articles meaning the same as *it*, *that* or *which*. *As* he sows, *so* he will reap, with the ellipses supplied is, (In) what (manner) he sows, (in) that he will reap, or even without supplying them, What he sows, that he will reap.

41. Prepositions, to use the ideas of Mr. Tooke, are necessary in language, because it is impossible to have a distinct complex term for each different collection of ideas which we have occasion to put together in discourse. By the aid of prepositions, complex terms are prevented from being indefinitely numerous, and are used only for those collections of ideas which we have most occasion to use. This end is thus answered: we either take that complex term which includes the greatest number, though not *all* of the ideas we would communicate, or else that which includes *all* and the fewest *more*; and then by the help of the preposition we either make up the deficiency in the one case, or retrench the superfluity in the other: so, a house *with* a party wall; a house *without* a roof. Other relations are declared by prepositions; but they have all meanings of their own, and are constantly used according to those meanings. *With* is the imperative of *withan*, to join: sometimes of *wyrthan*, to be; in which case it is exactly the same with *by*. *Through* or *thorough* is the Gothic substantive *dauro*, or the Teutonic *thuruh*, and like them means door, gate, passage: so, *through* the air, is, *passage* the air, or the air being the *passage* or *medium*. *From* is the Anglo-Saxon noun *frum*, beginning, source, author. Of this word Harris produces three examples, which he considers as proving that it is used in three different relations, *viz.* detached relation, quiescence, and motion, the last two being contradictory: these figs come *from* Turkey; the lamp hangs *from* the ceiling; the lamp falls *from* the

ceiling. Now *came* is a complex term for one species of motion; *falls* for another; *hangs* for a species of attachment. Have we occasion to mention the *beginning* or *commencement* of these motions and this attachment, and the place where they begin or commence? What more natural or more simple than to add the signs of these ideas, *viz.* the word *beginning* (which always remains the same,) and the name of the place (which will perpetually vary.) Figs came *beginning* Turkey; lamp $\left\{ \begin{matrix} \text{hangs} \\ \text{falls} \end{matrix} \right\}$ *beginning* ceiling: *i. e.* Turkey the *place* of *beginning* to come; ceiling the *place* of *beginning* to $\left\{ \begin{matrix} \text{hang.} \\ \text{fall.} \end{matrix} \right\}$ *To* is the Gothic substantive *taui*, act, effect, end, or result, which is itself the past participle of *taugan*, to do. *While* is an Anglo-Saxon substantive, signifying *time*; *till*, is *to-while*, to the time; *until*, is on to the time. *Of* is probably a fragment of the Anglo-Saxon substantive *afora*, offspring, &c. and always means consequence, offspring, succession, follower, &c. In all the instances produced in the dictionaries, *cause* may be substituted for *for*, without injury to the sense, though sometimes aukwardly. It is probably the Gothic substantive *fairina*, cause. *By* is the imperative of *be on*, to be; frequently, but not always, used with an abbreviation of construction, *instrument*, *cause*, *agent*, &c. being understood. *Among* is the past participle of *gamængan*, to mingle. *After* is the comparative of *aft*. *About* is from *boda* the first outward boundary or extremity of any thing; hence *onboda*, *onbuta*, *abuta*, *about*. *In*, *out*, *on*, *off*, and *at*, Mr. Tooke does not profess to trace to an origin; we feel little doubt that *on* is simply one of the several forms of the numeral *one*; and the same process of thought has occurred in the Greek, where *εις* and *εν* (and perhaps also *συν*) are almost indisputably the corresponding numeral. We should have thought it probable that the English *in* has the same origin as *on*, if Mr. H. Tooke had not produced the Gothic substantive *inna*, the interior part of the body (used also for cave or cell.) *Out* he thinks not improbably originally meant skin.

VIII. *Of the Interjection.*

42. We have very little to say in addition to what we have said respecting this small and insignificant class of words. *Oh*, or *O*, is almost the only word for which it is necessary. A few other words may be mentioned as being usually classed with it. *Farewell* is the imperative of *faran* to go, and the adverb *well*. *Halt* is the imperative of *healdan*, to hold. *Lo* is the imperative of look. *Fie* is the imperative of *fian*, to hate. *Welcome* means, it is *well* that you are come. *Adieu*, used so often without a moment's thought as to its serious import, is the French *à dieu*, *to God*, meaning, I commend you *to God*.

GRAMME, in French weights. The unit weight, called a gramme, is the weight of the cube of the hundredth part of the metre of distilled water, taken at its maximum density. It answers to 15.444 grains. The kilogramme, or the weight of a thousand grammes is equal to $32\frac{1}{6}$ Troy ounces.

GRANARY, a building to lay or store corn in, especially that designed to be kept a considerable time.

GRANATITE, *cross stone*, a mineral found in Spain, and in some parts of France and Switzerland. It is crystallized in a very peculiar form; two six-sided prisms intersect each other at right angles, or obliquely. Hence its name, cross stone. It is of a reddish brown colour: specific gravity 3.3, nearly. It is fusible before the blow-pipe. It consists of

Silica	33
Alumina	44
Lime	3.84
Oxide of iron	13
Oxide of manganese	1
	94.84
Loss	5.16
	100

GRAND *jury*. The sheriff of every county is bound to return, to every commission of oyer and terminer, and of goal delivery, and to every session of the peace, twenty-four good and lawful men of the county, some out of every hundred, to enquire, present, do, and execute all those things which on the part of our lord the King shall then and there be commanded them. They ought to be freeholders; but to what amount is not limited by law. Upon their appearance they are sworn upon the grand jury, to the amount of twelve at the least, and not more than twenty-three, that twelve may be a majority. They are only to hear evidence on behalf of the prosecution; for the finding of an indictment is only in the nature of an enquiry on accusation, which is afterwards to be tried; and

they are only to enquire, upon their oaths, whether there is sufficient cause to call upon the party to answer it. If twelve agree to find the bill, it must be pronounced a true bill, but it cannot be found by a smaller number. The mode of finding a bill is by indorsing it a true bill; when it is rejected it is indorsed "ignoramus," or not found; and no one can be tried by indictment without the finding by a grand jury.

GRAND *larceny*. See LARCENY.

GRANITE, in mineralogy, is a particular mountain rock, composed of felspar, quartz, and mica. In general the felspar is the predominating substance, and mica the least considerable. In some varieties the quartz is wanting, and in others the mica. The constituent parts differ likewise considerably in their magnitude: they alternate from large to small, and even very fine granular. The large and coarse usually belong to the oldest, and the small and fine granular to the newer granite formation. It differs also in colour, and this difference depends chiefly on the felspar, the quartz and mica being usually of a grey colour. The felspar passes from the white to the red. The felspar in granite has usually a vitreous lustre, and perfectly foliated fracture; in some varieties it passes into the earthy, with the loss of its lustre and hardness, even into porcelain earth. This is owing to decomposition, effected, according to Mr. Davy, by eletro-chemical agencies. Sometimes the constituent parts of granite are regularly crystallized, but principally the felspar and quartz. The mica sometimes occurs in nests, unmixed with the other parts. Sometimes the constituent parts are so arranged, that when a specimen is cut, its surface has a kind of resemblance to written characters. Hence it has been denominated GRAPHIC stone.

Besides felspar, quartz, and mica, the essential constituent parts of granite, other fossils occur in it; of these, schorl is the most frequent, and next is garnet and tinstone. There are three formations of granite; the first, or oldest, serves as the basis for all the other classes of rocks. The second occurs only in the first; and the third, or newest, appears to be among the newest of the primitive rocks. In the oldest granite formation, when it rises to a height above the surface of the earth, and is surrounded by other primitive rocks, these are always wrapped around it, or the strata are mantle-shaped. This is one of the most widely-extended and abundant formations with which we are acquainted. The second granite formation occurs only in veins, which traverse the oldest formation, but never reaches any of the newer rock. The newest granite formation always rests on some of the older primitive rocks, and usually in an overlying position. It never occurs in globular distinct concretions: its structure is very irregular; sometimes contains grains of precious garnet, and has a deep red colour. It often occurs in veins that shoot from the rock, or in veins that are not connected with any rock beyond the strata which they traverse.

When granite is exposed, it frequently occurs in high and steep cliffs, which form vast mural precipices: often also in lofty summits, denominated peaks. It is found in almost every country, and in many places the stones are of an immense size. The largest, as an unconnected stone, has been described in the sixty-eighth volume of the Philosophical Transactions. It is found near the Cape of Good Hope. Granite rocks are frequently traversed by rents, which widen by the action of the elements: the mass separates into fragments of greater or lesser magnitude, and they remain long piled on each other, in the most fanciful manner, appearing like vast artificial tumuli, or masses brought together by an immense flood. The hard white granite, with black spots, is a very valuable kind: it consists of congeries of variously constructed and differently coloured particles, not diffused among, nor running into one another, but each pure and distinct, though firmly adhering to which ever of the others it comes in contact with, and forming a very firm mass. It is much used in London for the steps of public buildings, and in other situations where great strength and hardness are required. The hard red granite, variegated with black and white, is common in Egypt and Arabia. The stones used in paving the streets is another species of granite. Granite, though not abounding in metal, contains occasionally some of the most important. Iron and tin occur most frequently.

GRANT, in law, a gift in writing of such a thing as cannot be passed or conveyed by word only, as a grant is the regular method, by the common law, of transferring the property of incorporeal hereditaments, or such things whereof no livery of seisin can be had. For which reason, all corporeal

hereditaments, as lands and houses, are said to be in livery; and the others, as advowsons, commons, services, rents, reversions, and the like, lie in grant. He that granteth is termed the grantor; and he to whom the grant is made is termed the grantee. A grant differs from a gift in this; that gifts are always gratuitous, grants are upon some consideration or equivalent. The operative words in grants are *dedi et concessi*, "I have given and granted." Grants may be void by incertainty, impossibility, being against law, or a wrong title, to defraud creditors, &c. Grants of the King are by letters patent, and are void when obtained by mistake or deceit apparent, or for an estate which cannot be granted, such as an estate to a man and his heirs male, without saying of his body; because it is neither an estate in fee nor in tail.

GRANULATION, in chemistry, the process by which a metal is reduced into grains, which is effected by melting the metal, and then pouring it in a very slender stream into cold water. As soon as the metal comes in contact with water it divides into drops, which have a tendency to a spherical shape, and are more or less perfect, according to the thinness of the stream; the height from which it falls, and the temperature of the metal. Some of the more fusible metals may be reduced to much finer grains, by pouring it in its melted state into a wooden box, rubbed over with chalk, and shaking it violently before it has time to become solid.

GRAPE. See VITIS. Grapes have been repeatedly examined by the best informed chemists and most accurate tests, but without that success which might have been expected. They are found to contain much sugar, a portion of mucilage and jelly, some albumen and colouring matter. Tartrate of potash, tartaric acid; the citric and malic acids have likewise been discovered in them.

GRAPHIC *gold*. See TELLURIUM.

GRAPHIC *stone*. See GRANITE.

GRAPHITES, a mineral principally of carbon, with a small portion of iron and silica. When pure it burns with a reddish flame, emitting beautiful sparks, and a smell of sulphur. Its specific gravity is about 2.; it feels somewhat greasy, stains the fingers, and marks strongly. It is a true carburet of iron, of which there are several species: one is plumbago, or black lead, so useful in the form of pencils. It consists of

Carbon	90
Iron	10
	100

GRAPHOMETER, a mathematical instrument, otherwise called a semi-circle, the use of which is to observe any angle, whose vertex is at the centre of the instrument in any plane (though it is most commonly horizontal, or nearly so) and to find how many degrees it contains.

The graphometer is a graduated semicircle, A B C, (see Plate VI. Miscel. fig. 5, 6, 7) made of wood, brass, or the like, and so fixed on a fulcrum, G H, by means of a brass ball and socket, that it easily turns about, and retains any situation It has two sights fixed on its diameter, A C, and at the centre there is commonly a magnetical needle and compass in a box. There is likewise a moveable ruler or index, E D, with two sights, P, P, which turns round the centre, and retains any situation given it.

To measure by this instrument an angle, A C B, in any plane, and comprehended between the right lines, A C and B C, drawn from two points, A and B, to the place of station, C. Let the graphometer be placed at C, supported by its fulcrum; and let the immovable sights on the diameter of the instrument, D E, be directed towards the point, A; and likewise while the instrument remains immoveable, let the sights of the ruler, F G, which is moveable about the centre, C, be directed to the point, B. Now it is evident, that the moveable ruler cuts off an arch, D H, which is the measure of the angle, A C B, sought. Moreover, by the same method, the inclination of D E, or of F G, may be observed with the meridian line, which is pointed out by the magnetic needle inclosed in the box, and moveable about the centre of the instrument.

GRAPNELS, a sort of anchors with four flukes, serving for boats to ride by.

There is also a kind called fire and chain-grapnels, made with four barbed claws, instead of flukes, and used to catch hold of the enemy's rigging, or any other part, in order for boarding them.

A fire grapnel, in some respects, resembles the former, but differing in the construction of its flukes, which are furnished with strong barbs on its points. Fire grap-

nels are usually fixed by a chain on the yard-arms of a ship, to grapple any adversary whom she intends to board, and are particularly requisite in fire-ships.

GRASS, in botany. The tribe of grasses is one of the seven natural families into which all vegetables are distributed by Linnæus in his "Philosophia Botanica." They are defined to be plants which have very simple leaves, a jointed stem, a husky calyx named a glume, and a single seed. This description includes corn as well as the grasses.

Most of these plants are annual or perennial herbs; some of them are erect, others creep upon the ground. The roots, in the greatest number creep, and emit fibres from each knot or joint; in others, they are simply branched and fibrous. The stems and branches are round; the leaves are simple, alternate, entire, very long, and commonly narrow; they are generally placed immediately upon the stem, except in the bamboo, and a few others, which have a foot stalk at the origin of the leaves. The leaves form below a sort of sheath, which embraces the stem, and is generally cleft on one side through its whole length. The top of the sheath is sometimes crowned with a membrane, that is either cleft or entire, and is frequently accompanied with two appendages or ears, as in rice, pharus, darnel, wheat, rye, and barley. In others, the sheath is crowned with hairs, as in millet, panic-grass, and andropogon, and in some species of panic grass it is naked, that is, has neither membrane nor hairs. There are three sections. The flowers are hermaphrodite in plants of the first section; male and female upon the same root in those of the second; hermaphrodite and male on the same root in those of the third. They proceed either singly from the sheath of the leaves, as in lygeum; form a single spike, as in nardus and darnel; or are formed into a panicle, that is, loose spike, as in poa, agrestis, and oats. The calyx and corolla in this order are not sufficiently ascertained. In some a single scale or husk, in others two, as in nardus, supply the place of both covers; some grasses, as canary-grass, and phleum, have four husky scales, two of which serve for the calyx, and the other two for the corolla; some have five, as anthoxanthum; others six, as rice, four of which are supposed to constitute the calyx, and the other two are termed, improperly enough, the husky petals. The corolla is sometimes composed of one petal with two divisions, as in fox-tail grass. The stamina are generally three in number, and placed irregularly with respect to the situation of the calyx and the corolla. One stamen is commonly placed betwixt the seed bud and the two small scales or external husk of the corolla; and two betwixt the seed bud and the inner husk. Rice, zizania, and pharus, have six stamina. The anthers are long, furnished, with two cells, and slightly attached to the filaments. The seed bud is placed upon the same receptacle as the calyx, corolla, and stamina. In bobartia it is said to be placed under the receptacle of the flower. The style is generally double, and crowned with a hairy stigma or summit. The seed vessel in this order is wanting. The seeds are single, oval, and attached below to the bottom of the flower.

GRATIOLA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx seven-leaved, the two outer leaves petulous; corolla irregular, reversed; stamen two, barren; capsule two-celled. There are twelve species.

GRAVE, in music, is applied to a sound which is of a low or deep tone. The thicker the cord or string, the more grave is the note or tone; and the smaller, the more acute. The gravity of sounds depends on the slowness of the vibratory motions of the chord; and their acuteness on its quick vibrations. Grave, in the Italian music, denotes a very grave and slow motion, somewhat faster than adagio, and slower than largo.

Grave *accent*, in grammar, shews that the voice is to be lowered; its mark stands thus \`. See Accent.

Grave *digging beetle*. See Silpha.

GRAVEL, in natural history and gardening, a congeries of pebbles, which, mixed with a stiff loam, makes lasting and elegant gravel walks; an ornament peculiar to our gardens, and which gives them the advantage over those of other nations.

GRAVER, in the art of engraving, a tool by which all the lines, scratches, and shades, are cut in copper, &c. Gravers are of three sorts, round-pointed, square-pointed, and lozenge. The round are the best for scratching; the square-pointed are for cutting the largest strokes, and the lozenge-pointed ones for the most fine and delicate strokes; but a graver of a middle form, between the square and lozenge-pointed, will make the strokes or scratches appear

with more life and vigour. See ENGRAVING.

GRAVIMETER, the name given by M. Guyton to an instrument for measuring specific gravities: he adopts this name rather than either areometer or hydrometer, because these latter terms are grounded upon the supposition that a fluid is always the thing weighed; whereas, with regard to solids, the liquid is the known term of comparison to which the unknown weight is referred. Guyton's gravimeter is executed in glass, and is of a cylindric form, being that which requires the smallest quantity of fluid, and is on that account preferable, except so far as it is necessary to deviate for the security of a vertical position. It carries two basins, one of them superior, at the extremity of a thin stem, towards the middle of which the fixed point of immersion is marked. The other, or lower basin, terminates in a point; it contains the balls, and is attached to the cylinder by two branches. The moveable suspension, by means of a hook, has the inconvenience of shortening the lever which is to secure the vertical position. The cylinder is three fourths of an inch in diameter, and 6.85 inches in length. It carries in the upper basin an additional constant weight of five grammes, or one hundred and fifteen grains. These dimensions might be increased so as to render it capable of receiving a much more considerable weight; but this is unnecessary. M. Guyton has added a piece which he calls the plonguer, because, in fact, it is placed in the lower basin when used, and is consequently entirely immersed in the fluid. It is a bulb of glass loaded with a sufficient quantity of mercury, in order that its total weight may be equal to the constant additional weight added to the weight of the volume of water displaced by this piece. It will be readily understood that the weight being determined at the same temperature at which the instrument was originally adjusted, it will sink to the same mark on the stem, whether it is loaded with a constant additional weight in the upper basin, or whether the effect of this weight be produced by the additional piece in the lower dish. From this explanation there will be no difficulty in seeing how this instrument may be adapted to every case in practice. It may be used, 1. For solids. The only condition will be, that the absolute weight of the body to be examined shall be rather less than the constant additional weight, which in this instrument is about 115 grains. 2. For liquids of less specific gravity than water, the instrument, without the additional weight above-mentioned, weighs about four hundred and fifty-nine grains, in the dimensions before laid down. It would be easy to limit its weight to the utmost accuracy. We have therefore the range of one-fifth of buoyancy, and consequently the means of ascertaining all the intermediate densities from water to the most highly rectified spirit of wine, which is known to bear in this respect the ratio of eight to ten with regard to water. 3. When liquids of greater specific gravity than water are to be tried, the constant weight being applied below by means of the additional piece, which weighs about one hundred and thirty-eight grains, the instrument can receive in the upper basin more than four times the usual additional weight, without losing the equilibrium of its vertical position. In this state it is capable of shewing the specific gravity of the most concentrated acids. 4. It possesses another property, namely, that it may be used as a balance to determine the absolute weight of such bodies as do not exceed its additional load. 5. Lastly, the purity of the water being known, it will indicate the degrees of rarefaction and condensation in proportion to its own bulk. To find the specific gravity of any solid by the gravimeter, observe this rule: "From the weight in the upper dish, when the instrument is properly immersed in the unknown fluid, take the weight which is placed with the body in the same scale at the like adjustment. The remainder is the absolute weight of the solid. Multiply this by the specific gravity of the fluid, and reserve the product. From the additional weight, when the body is placed in the lower basin, take the weight when it was placed in the upper. The remainder will be the loss of weight by immersion. Divide the reserved product by the loss by immersion, and the quotient will be the specific gravity of the solid with regard to distilled water at the standard temperature and pressure." To find the specific gravity of a fluid, proceed thus: "To the weight of the gravimeter add the weight required in the upper basin to sink it in the unknown fluid." Again, "To the weight of the gravimeter add the weight required in the same manner to sink it in distilled water. Divide the first sum by the latter, and the quotient will be the specific gravity of the fluid in question." See SPECIFIC GRAVITY, HYDROSTATICS, and HYDROMETER.

GRAVING. See ENGRAVING. In sea affairs the word graving is used for the act of cleaning a ship's bottom, when she is laid aground during the recess of the tide. See BREAMING and CAREENING.

GRAVITY, a term used by physical writers to denote the cause by which all bodies move toward each other, unless prevented by some other force or obstacle. The most familiar effect, and that which continually obtrudes itself on our notice, is the weight of bodies, or their tendency toward the centre of the earth. It has not been ascertained, or rendered probable, that gravity is a secondary property of matter; that is to say, that it flows from any of the other known original properties. Sir Isaac Newton, however, was of opinion, that our reasonings on the subject might be simplified, by supposing it to depend on a prodigiously elastic and rare fluid, by him called ether, and assumed to possess an increasing degree of condensation, in parts of space more and more remote from the various masses of matter. According to this doctrine, a falling body moves, because it is pressed toward the rarer parts of this extended fluid. We shall leave this theory to its merits, as being neither very perspicuous, nor much related to our subject. Bergman, and others, have considered the chemical and cohesive attractions to be one and the same with the attraction of gravity, but modified in its laws, by variations in the masses, densities, and distances of the particles of bodies. Many difficulties appear at first sight to offer themselves against this supposition. But in truth it cannot be examined at first sight; and requires to be submitted to the rigour of mathematical investigation, which has not yet been done.

The phenomena of particular gravity, or that which respects the earth, or by which bodies descend or tend towards the centre of the earth, are as follows:

1. All circumterrestrial bodies do hereby tend towards a point, which is either accurately, or very nearly, the centre of the magnitude of the terraqueous globe. Not that it is meant, that there is any virtue or charm in the point called the centre, by which it attracts bodies; but because this is the result of the gravitation of bodies towards all parts of which the earth consists.

2. In all places equidistant from the centre of the earth, the force of gravity is nearly equal. Indeed all parts at the earth's surface are not at equal distances from the earth's centre, because the equatorial parts are higher than the polar parts by about seventeen miles; as has been proved by the necessity of making the pendulum shorter in those places, before it will swing seconds. In the new "Petersburg Transactions," vol. 6 and 7. M. Krafft gives a formula for the proportion of gravity in different latitudes on the earth's surface, which is this:

$$y = (1 + 0.0052848 \text{ sine }^2\lambda)\, g;$$

where g denotes the gravity at the equator, and y the gravity under the other latitude λ.

3. Gravity equally affects all bodies, without regard either to their bulk, figure, or matter: so that abstracting from the resistance of the medium, the most compact and the most loose, the greatest and the smallest bodies would all descend through an equal space in the same time, as appears from the quick descent of every light body in an exhausted receiver. The space which bodies do actually fall in vacuo, is $16\frac{1}{12}$ feet in the first second of time, in the latitude of London; and for other times, either greater or less than that, the spaces descended from rest, are directly proportional to the squares of the times, while the falling body is not far from the earth's surface.

4. This power is the greatest at the earth's surface, from whence it decreases both upwards and downwards; but not both ways in the same proportion; for upwards, the force of gravity is less, or decreases as the square of the distance from the centre increases; so that at a double distance from the centre above the surface, the force would be only one-fourth of what it is at the surface; but below the surface, the power decreases in such sort, that its intensity is in the direct ratio of the distance from the centre; so that at the distance of half a semi-diameter from the centre, the force would be but half what it is at the surface; at one-third of a semi-diameter the force would be but one-third, and so on.

5. As all bodies gravitate towards the earth, so does the earth gravitate towards all bodies; as well as all bodies towards particular parts of the earth, as hills, &c. which has been proved by the attraction a hill has upon a plumb line, insensibly drawing it aside. Hence the gravitating force of entire bodies, consists of those of all their parts; for, by adding or taking away any part of the matter of a body, its gravity is increased or decreased, in the pro-

portion of the quantity of such portions to the whole mass. Hence also the gravitating powers of bodies at the same distance from the centre are proportional to the quantities of matter in the bodies.

General or universal gravity, is that by which all the planets tend towards one another; and indeed, by which all bodies or particles of matter in the universe tend towards one another.

The existence of the same principles of gravitation in the superior regions of the heavens as on the earth, is one of the great discoveries of Newton, who made the proof of it as easy as that on the earth. This was at first only a conjecture in his mind: he observed, that all bodies near the earth, and in its atmosphere, had the property of tending directly towards it; he soon conjectured, that it probably extended much higher than to any distance to which we could reach to make experiments; and so on, from one distance to another, till he at length saw no reason why it might not extend to the moon, by means of which she might be retained in her orbit, as a stone in a sling is retained by the hand; and if so, he next inferred, why might not a similar principle exist in the other great bodies in the universe, the sun, and all the other planets, both primary and secondary, which might all be retained in their orbits, and perform their revolutions by means of the same universal principle of gravitation.

He soon realized and verified these by mathematical proofs. Kepler had found out, by contemplating the motions of the planets about the sun, that the area decribed by a line connecting the sun and planet, as this revolved in its orbit, was always proportional to the time of its description, or that it described equal areas in equal times in whatever part of its orbit the planet might be, moving always as much the quicker as its distance from the sun was less. And it is also found, that the satellites, or secondary planets, respect the same law in revolving about their primaries. But it was soon proved, by Newton, that all bodies moving in any curve line described on a plane, and which, by radii drawn to any certain point, describes areas about the point proportional to the times, are impelled or acted on by some power tending towards that point. Consequently, the power by which all these planets revolve, and are retained in their orbits, is directed to the centre about which they move, *viz.* the primary planets to the sun, and the satellites to their several primaries.

Again, Newton demonstrates that if several bodies revolve with an equable motion in several circles about the same centre, and that if the squares of their periodical times be in the same proportion as the cubes of their distances from the common centre, then the centripetal forces of the revolving bodies, by which they tend to their central body, will be in the reciprocal or inverse ratio of the squares of the distances. But it had been agreed on by the astronomers, and particularly Kepler, that both these cases obtain in all the planets; and therefore he inferred that the centripetal forces of all the planets were reciprocally proportional to squares of the distances from the centres of their orbits.

Upon the whole, it appears that the planets are retained in their orbits by some power which is continually acting upon them: that this power is directed towards the centre of their orbits: that the intensity or efficacy of this power increases upon an approach towards the centre, and diminishes on receding from the same, and that in the reciprocal duplicate ratio of the distances; and that by comparing this centripetal force with the force of gravity on the earth, they are found to be perfectly alike, as may easily be shown in various instances. For example, in the case of the moon, the nearest of all the planets, the rectilinear spaces described in any given time, by a body urged by any power, reckoning from the beginning of its descent, are proportionate to those powers. Consequently the centripetal force of the moon, revolving in its orbit, will be to the force of gravity on the surface of the earth as the space which the moon would describe in falling, during any small time, by her centripetal force towards the earth, if she had no motion at all, to the space a body near the earth would describe in falling by its gravity towards the same.

Now by an easy calculation of these two spaces, it appears that the former force is to the latter as the square of the semidiameter of the earth is to the square of that of the moon's orbit. The moon's centripetal force, therefore, is equal to the force of gravity; and consequently these forces are not different, but they are one and the same: for if they were different bodies acted on by the two powers conjointly, would fall towards the earth with a velocity double to that arising from the sole power of gravity.

It is evident, therefore, that the moon's centripetal force, by which she is retained

in her orbit, and prevented from running off in tangents, is the very power of gravity of the earth extended thither. See "Newton's Principia," lib. i. prop. 45, cor. 2, and lib. iii. prop. 3; where the numeral calculation may be seen at full length.

The moon, therefore, gravitates towards the earth, and reciprocally the earth towards the moon, and this is also farther confirmed by the phenomena of the tides.

The like reasoning may also be applied to the other planets. For as the revolutions of the primary planets round the sun, and those of the satellites of Jupiter and Saturn round their primaries, are phenomena of the same kind with the revolution of the moon about the earth; and as the centripetal powers of the primary are directed towards the centre of the sun, and those of the satellites towards the centres of their primaries; and, lastly, as all these powers are reciprocally as the squares of the distances from the centres, it may safely be concluded, that the power and cause are the same in all. Therefore, as the moon gravitates towards the earth, and the earth towards the moon, so do all the secondaries to their primaries, and these to the secondaries; and so also do the primaries to the sun, and the sun to the primaries. Newton's Princip. lib. iii, prop. 4, 5, 6; Greg. Astron. lib. i. sect. 7, prop. 46 and 47.

The laws of universal gravity are the same as those of bodies gravitating towards the earth, before laid down. See ASTRONOMY, ATTRACTION, GEOGRAPHY.

GRAVITY, *specific.* Boyle is among the first of our philosophers, who suggested the advantage that chemistry and mineralogy might derive from an attention to the specific gravities of bodies. Much advantage may indeed be derived from this property in the general determination of the classes of minerals, and the purity of some metallic bodies; and it is very probable, that an attention to the specific gravities, capacities for heat, fusibilities, volatilities, laws of crystallization, elasticity, hardness, tenacity, malleability, and some other obvious specific properties of bodies, may produce a more intimate acquaintance with the mutual actions of their particles, than any we have hitherto acquired.

Annexed to this article is a table of specific gravities, from various authors. It appeared useless to carry it to more than four places of figures, as the temperatures are not noted; and the various specimens of the same substance often differ in the third figure. Besides this, it is remarked by Nicholson, in his "Chemical Dictionary," that the fifth figure changes in water at every three degrees of Fahrenheit's thermometer; that lead, tin, and probably all other metals, though cast out of the same fusion, will vary in their specific gravities in the third figure, from circumstances not yet determined, but most likely from the cooling, as is seen in the hardening of steel; that salts, and other artificial preparations, retain more or less of the solvent they were separated from, according to the temperature at which the crystallization was effected; and that all parts of organized substances not only differ according to the place of their production, their age, and other circumstances, but likewise from their dryness, moisture, and manner of preservation.

The specific gravity of solids is determined by weighing them first in air, and then in water. The loss of weight, arising from the action of the water, is equal to that of a mass of the fluid possessing the same dimensions as the solid itself. Whence it is easy to construct a general table of specific gravities, by reducing the proportion of the absolute weight to the loss sustained by immersion, into terms of which that expressing water shall be unity. If the solid be so light as to float upon water, it is convenient to attach to it a heavier body sufficient to cause it to sink, but the weight of which in water must be added in computing the loss. The specific gravity of fluids is ascertained by weighing a known body immersed in them. For the loss by immersion will accurately show the weight of the same bulk of the fluid; and, consequently, the proportion of these several quantities to the loss the same solid sustained in water, being reduced as in the other case to the common standard of unity, will exhibit the specific gravity. Other methods are likewise used in experiments with fluids. Thus equal bulks of different fluids may be weighed by filling a small bottle with a ground stopper with each respectively, and from their several weights the weight of the bottle and stopper must be deducted. Or otherwise, the instrument called the hydrometer may be used. See HYDROMETER. This possesses the advantage of portability, speed, and a degree of accuracy not easily obtained by the use of ordinary balances.

A TABLE

Shewing the Specific Gravity of Metals and other bodies to Rain Water, and the Weight of a Cubic Inch of each in parts of a Pound Avoirdupoise. The Number in the Column, Specific Gravity, shows the Ounces Avoirdupoise in the Cubic Foot of each Body.

Bodies.	Sp. Grav.	W. lb. Av.
Pure gold cast	19258	0.71036
——— hammered	19362	0.70030
Standard gold cast	17486	0.63250
——— hammered	17589	0.63618
Pure silver cast	10474	0.37796
——— hammered	10511	0.38017
Standard silver in coin	10391	0.87580
Crude platina in grains	15602	0.56431
Platina purified and fused	19500	0.70530
——— hammered	20377	0.73557
——— drawn into wire	21042	0.76107
——— laminated	22069	0.79821
Mercury	13568	0.49074
Lead fused	11352	0.40965
Copper fused	7788	0.28168
——— drawn into wire	8878	0.32111
Brass cast	8396	9.30367
——— in wire	8544	0.30903
Iron cast	7207	0.26067
——— bar	7788	0.28168
Steel soft, and not hammered	7840	0.28356
——— hardened	7816	0.28270
Tin, English, fused	7291	0.26371
——— hammered	7299	0.26400
Malacca tin fused	7296	0.26382
——— hammered	7306	0.26486
Bismuth	9823	0.35529
Nickel	8660	0.31323
Arsenic, the metal	5763	0.20844
Cobalt	7812	0.28255
Zinc	7191	0.26009
Antimony	6702	0.24240
Manganese	6850	0.24776
Wolfran	17600	0.63657
Diamond	3251	0.11759
Ruby	4283	0.15491
——— Spinell	3760	0.13600
Topaz, Oriental	4011	0.14507
——— Brazilian	3536	0.11718
——— Saxon	3564	0.12891
Sapphire, Oriental	3994	0.14446
Emerald	2775	0.10037
Adamantine spar	4180	0.15118
Rock crystal from Madagascar	2653	0.09596
Quartz	2654	0.09599
Agate	2590	0.09368
Onyx	2376	0.09537

Bodies.	Sp. Grav.	W. lb. Av.
Muscovy talc	2792	0.10098
Common slate	2672	0.09664
Calcareous spar	2715	0.09820
Alabaster	2730	0.09874
White marble	2716	0.09823
Limestones, from	1386	0.05113
———, to	2390	0.08644
Ponderous spar	4474	0.16182
Fluor spar	3180	0.11502
Pumice-stone	914	0.03306
Green glass	2620	0.09476
English crown glass	2520	0.09115
White flint glass, English	3290	0.11900
Another piece	3216	0.11632
White flint glass for achromatic uses	3437	0.12431
White glass, French	2892	0.10460
Glass of S. Gobin	2488	0.09000
Brimstone	1990	0.07198
Phosphorus	1714	0.06199
Yellow amber	1078	0.3899
Distilled water	1000	0.03617
Sea water	1026	0.03711
Common spirit of wine	837	0.03027
Spirit of wine, the purest that can be had by mere distillation	820	0.2960
Sulphuric ether	739	0.02673
Nitrous	909	0.03288
Marine	730	0.02640
Acetous	866	0.03132
Concentrated sulph. acid	2125	0.07686
——— nitric acid	1580	0.05714
——— muriatic acid	1194	0.04319
Fluor acid	1500	0.05425
Oil of olives	915	0.03309
——— of sweet almonds	917	0.03316
Linseed oil	940	0.03400
Naptha	708	0.02561
Gum elastic	393	0.03375
Camphor	989	0.03577
Yellow wax	965	0.03490
White ditto	969	0.03505
Spermaceti	943	0.03411
Tallow	942	0.03407
Heart of oak	1170	0.04232
Cork	240	0.01868

For the specific gravities of different kinds of elastic fluids, see the Table at the end of the article GAS.

Gravity, in music, is the modification of any sound by which it becomes deep or low in respect of some other sound. The gravity of sounds depends on the thickness and distension of the chords, or the length and diameter of the pipes, and in general on the mass, extent, and tension of the sonorous bodies. The larger and more lax the bodies, the slower will be the vibrations and the graver the sounds.

GREASE. See Farriery.

GREAT *circle sailing*, the manner of conducting a ship in, or rather pretty near the arch of a great circle, that passes through the zenith of the two places, *viz.* from whence she came, and to which she is bound.

GREEK *church.* In the eighth century there arose a difference between the eastern and western churches, which, in the course of about two centuries and a half ended in a total separation. The Greek, or Eastern, or as it is sometimes called the Russian church, spread itself over the eastern parts of Europe. It bears a considerable resemblance to the church of Rome, but denies the infallibility and supremacy of the Pope: it rejects also the worship of images, and the doctrine of consubstantiation, or the union of the body of Christ with the sacramental elements. The administration of baptism is performed by immersing the whole body. The Greek church has the same division of clergy, and the same distinction of ranks and offices with the church of Rome.

GREEN, one of the original colours excited by the rays of light. See Chromatics, Colours, and Optics. The green colour of plants has been shown, by the French chemists, to depend upon the absorption of carbonic acid, and it is supposed that the leaves of plants have the power of decomposing the carbonic acid and water also; the oxygen they emit, while the carbon and hydrogen enter into the composition of the inflammable parts of the plant.

Green, *Brunswick*, a pigment used by German artists, and known in our shops under that name. It is made by saturating cold water with muriated ammonia, and adding three times as much copper clipping as ammonia. The moisture is to be evaporated, taking care that no dust be allowed to get to it. The muriate of ammonia is decomposed by the copper, which is itself corroded and converted into a green oxide. It is then to be digested in successive portions of alcohol, as long as any green oxide is taken up; the solutions are now to be added together, and the liquor to be driven off by a moderate heat; the residue is the pigment required.

Green *cloth*, a board or court of justice, held in the counting-house of the king's household, composed of the lord-steward, and officers under him, who sit daily. To this court is committed the charge and oversight of the king's household in matters of justice and government, with a power to correct all offenders, and to maintain the peace of the verge, or jurisdiction of the court-royal; which is every way about two hundred yards from the last gate of the palace where his Majesty resides. It takes its name, board of green-cloth, from a green cloth spread over the board where they sit. Without a warrant first obtained from this court, none of the king's servants can be arrested for debt.

Green *finch.* See Fringilla.

GREENHOUSE, or conservatory, a house in a garden contrived for sheltering and preserving the most tender and curious exotic plants, which, in our climate, will not bear to be exposed to the open air during the winter season. These are generally large and beautiful structures, equally ornamental and useful.

GREGORIAN *calendar*, that which shows the new and full moon, with the time of Easter, and the moveable feasts depending thereon, by means of epacts, disposed through the several months of the Gregorian year.

Gregorian *epoch*, the epocha, or time whence the Gregorian calendar or computation took place. The year 1808 is the 226th year of that epocha.

Gregorian *year*, the Julian year corrected, or modelled, in such a manner as that three secular years, which in the Julian account are bissextile, are here common years, and only every fourth secular year is made a bissextile year.

The Julian computation is more than the solar year by eleven minutes, which in one hundred and thirty-one years amounts to a whole day. By this calculation, the vernal equinox was anticipated ten days from the time of the general council of Nice, held in the year 325 of the Christian æra, to the time of Pope Gregory XIII. who therefore caused ten days to be taken out of the month of October, in 1582, to make the equinox fall on the twenty-first of March, as it did at the time of that council, and to prevent the like variation for the

future, he ordered that three days should be abated in every four hundred years by reducing the leap year at the close of each century for three successive centuries to common years, and retaining the leap year at the close of each fourth century only.

This was at that time esteemed as exactly conformable to the true solar year, but it is found not to be strictly just, because that in four hundred years it gets one hour and twenty minutes, and consequently in 7200 years, a whole day.

The greatest part of Europe have long used the Gregorian style: but Great Britain retained the Julian till the year 1752, when by act of parliament this style was adjusted to the Gregorian; since which time Sweden, Denmark, and other European states, who computed time by the Julian account, have followed this example.

GREGORY (James), professor of mathematics, first in the university of St. Andrew's, and afterwards in that of Edinburgh, was one of the most eminent mathematicians of the seventeenth century. He was a son of the Rev. John Gregory, minister of Drumoak, in the county of Aberdeen, and was born at Aberdeen, in November 1638. His mother was a daughter of Mr. David Anderson, of Finzaugh, or Finshaugh; a gentleman who possessed a singular turn for mathematical and mechanical knowledge. This mathematical genius was hereditary in the family of the Andersons, and from them it seems to have been transmitted to their descendants of the names of Gregory, Reid, &c. Alexander Anderson, cousin german of the said David, was professor of mathematics at Paris in the beginning of the 17th century, and published there several valuable and ingenious works. The mother of James Gregory inherited the genius of her family; and observing in her son, while yet a child, a strong propensity to mathematics, she instructed him herself in the elements of that science. His education in the languages he received at the grammar-school of Aberdeen, and went through the usual course of academical studies in the Marischal college; but he was chiefly delighted with philosophical researches, into which a new door had lately been opened by the key of the mathematics.

Galileo, Kepler, Des Cartes, &c. were the great masters of this new method: their works therefore became the principal study of young Gregory, who soon began to make improvements upon their discoveries in Optics. The first of these improvements was the invention of the reflecting telescope; the construction of which instrument he published in his "Optica Promota," in 1663, at twenty-four years of age. This discovery soon attracted the attention of the mathematicians, both of our own, and of foreign countries, who immediately perceived its great importance to the sciences of optics and astronomy. But the manner of placing the two specula upon the same axis appearing to Newton to be attended with the disadvantage of losing the central rays of the larger speculum, he proposed an improvement on the instrument, by giving an oblique position to the smaller speculum, and placing the eye-glass in the side of the tube. It is observable, however, that the Newtonian construction of that instrument was long abandoned for the original, or Gregorian, which is now always used when the instrument is of a moderate size; though Herschell has preferred the Newtonian form for the construction of those immense telescopes, which he has of late so successfully employed in observing the heavens.

About the year 1664, or 1665, coming to London, he became acquainted with Mr. John Collins, who recommended him to the best optic glass-grinders there to have his telescope executed. But as this could not be done for want of skill in the artists to grind a plate of metal for the object speculum into a true parabolic concave, which the design required, he was much discouraged with the disappointment; and, after a few imperfect trials made with an ill-polished spherical one, which did not succeed to his wish, he dropped the pursuit, and resolved to make the tour of Italy, then the mart of mathematical learning, that he might prosecute his favourite study with greater advantage. And the University of Padua, being at that time in high reputation for mathematical studies, Mr. Gregory fixed his residence there for some years. Here it was that he published, in 1667, "Vera Circuli et Hyperbolæ Quadratura;" in which he propounded another discovery of his own, the invention of an infinitely converging series for the areas of the circle and hyperbola. He sent home a copy of this work to his friend Mr. Collins, who communicated it to the Royal Society, where it met with the commendations of Lord Brounker and Dr. Wallis. He reprinted it at Venice the following year, to which he added a new work, entitled

"Geometriæ Pars Universalis, inserviens Quantitatum Curvarum, Transmutationi et Mensuræ"; in which he is allowed to have shown, for the first time, a method for the transmutation of curves. These works engaged the notice, and procured the author the correspondence of the greatest mathematicians of the age, Newton, Huygens, Wallis, and others. An account of this piece was also read before the Royal Society, of which Mr. Gregory, being returned from his travels, was chosen a member the same year, and communicated to them an account of a controversy in Italy about the motion of the earth, which was denied by Riccioli, and his followers. Through this channel, in particular, he carried on a dispute with M. Huygens, on the occasion of his treatise on the quadrature of the circle and hyperbola, to which that great man had started some objections; in the course of which our author produced some improvements of his series. But in this dispute it happened, as it generally does on such occasions, that the antagonists, though setting out with temper enough, yet grew too warm in the combat. This was the case here, especially on the side of Gregory whose defence was, at his own request, inserted in the Philosophical Transactions. It is unnecessary to enter into particulars: suffice it therefore to say that, in the opinion of Leibnitz, who allows Mr. Gregory, the highest merit for his genius and discoveries, M. Huygens has pointed out, though not errors, some considerable deficiencies in the treatise above-mentioned, and shown a much simpler method of attaining the same end.

In 1688, our author published at London another work, entitled "Exercitationes Geometricæ," which contributed still much further to extend his reputation. About this time he was elected Professor of Mathematics in the University of St. Andrew's, an office which he held for six years. During his residence there he married, in 1669, Mary, the daughter of George Jameson, the celebrated painter, whom Mr. Walpole has termed the Vandyke of Scotland, and who was fellow-disciple with that great artist in the school of Rubens, at Antwerp.

In 1672, he published "The great and new Art of weighing Vanity: or a Discovery of the Ignorance and Arrogance of the great and new Artist, in his pseudo-philosophical Writings. By M. Patrick Mathers, Archbedal to the University of St. Andrews. To which are annexed some Tentamina de Motu Penduli et Projectorum." Under this assumed name, our author wrote this little piece to expose the ignorance of Mr. Sinclare, professor at Glasgow, in his hydrostatical writings, and in return for some ill usage of that author to a colleague of Mr. Gregory's. The same year Newton, on his wonderful discoveries in the nature of light, having contrived a new reflecting telescope, and made several objections to Mr. Gregory's, this gave birth to a dispute between those two philosophers, which was carried on during this and the following year, in the most amicable manner on both sides; Mr. Gregory defending his own construction, so far as to give his antagonist the whole honour of having made the catoptric telescopes preferable to the dioptric, and showing that the imperfections in these instruments were not so much owing to a defect in the object speculum, as to the different refrangibility of the rays of light.—In the course of this dispute our author described a burning concave mirror, which was approved by Newton, and is still in good esteem. Several letters that passed in this dispute, are printed by Dr. Desaguliers, in an appendix to the English edition of Dr. David Gregory's "Elements of Catoptrics and Dioptrics."

In 1674, Mr. Gregory was called to Edinburgh, to fill the chair of mathematics in that university. This place he had held but little more than a year, when in October 1675, being employed in shewing the satellites of Jupiter through a telescope to some of his pupils, he was suddenly struck with total blindness, and died a few days after, to the great loss of the mathematical world, at only 37 years of age.

As to his character, Mr. James Gregory was a man of very acute and penetrating genius. His temper seems to have been warm, as appears from his conduct in the dispute with Huygens: and conscious perhaps of his own merits as a discoverer, he seems to have been jealous of losing any portion of his reputation by the improvements of others upon his inventions. He possessed one of the most amiable characters of a true philosopher, that of being content with his fortune in his situation. But the most brilliant part of his character is that of his mathematical genius as an inventor, which was of the first order; as will appear by the following list of his inventions and discoveries. Among many others may be reckoned his reflecting teles-

scope; burning concave mirror; quadrature of the circle and hyperbola, by an infinite converging series; his method for the transformation of curves; a geometrical demonstration of Lord Brounkers' series for squaring the hyperbola; his demonstration that the meridian line is analogous to a scale of logarithmic tangents of the half-complements of the latitude; he also invented and demonstrated geometrically, by help of the hyperbola, a very simple converging series for making the logarithms; he sent to Mr. Collins the solution of the famous Keplerian problem by an infinite series; he discovered a method of drawing tangents to curves geometrically, without any previous calculations; a rule for the direct and inverse method of tangents, which stands upon the same principle (of exhaustions) with that of fluxions, and differs not much from it in the manner of application; a series for the length of the arc of a circle, from the tangent, and vice versâ. These, with others for measuring the length of the elliptic and hyperbolic curves, were sent to Mr. Collins, in return for some received from him of Newton's, in which he followed the elegant example of this author, in delivering his series in simple terms, independently of each other. These and other writings of our author are mostly contained in the following works, *viz.*: 1. Optica Promota; 4to. London, 1663. 2. Vera Circuli et Hyperbolæ Quadratura, 4to. Padua, 1667 and 1668. 3. Geometriæ Pars Universalis, 4to. Padua, 1668. 4. Exercitationes Geometricæ, 4to. London 1668. 5. The great and new Art of weighing Vanity, 8vo. Glasgow, 1672. The rest of his inventions make the subject of several letters and papers, printed either in the Philos. Trans. vol. iii., the Commerc. Epistol. Joh. Collins, et aliorum, 8vo. 1715, in the appendix to the English edition of Dr. David Gregory's Elements of Optics, 8vo. 1735, by Dr. Desaguliers, and some series in the Exercitatio Geometrica of the same author, 4to. 1684, Edinburgh; as well as in his little piece on Practical Geometry.

Gregory (Dr. David,) Savilian professor of astronomy, at Oxford, was nephew of the above-mentioned Mr. James Gregory, being the eldest son of his brother, Mr. David Gregory, of Kinardie, a gentleman who had the singular fortune to see three of his sons all professors of mathematics, at the same time, in three of the British universities, viz. our author David at Oxford, the second son James, at Edinburgh, and, the third son Charles at St. Andrew's. Our author David, the eldest son, was born at Aberdeen, in 1661, where he received the early parts of his education, but completed his studies at Edinburgh: and, being possessed of the mathematical papers of his uncle, soon distinguished himself likewise as the heir of his genius. In the 23d year of his age, he was elected professor of mathematics in the university of Edinburgh; and, in the same year he published "Exercitatio Geometrica de Dimensione Figurarum, sive Specimen Methodi generalis dimetiendi quasvis Figuras, Edinb. 1684, 4to. He very soon perceived the excellence of the Newtonian philosophy, and had the merit of being the first that introduced it into the schools, by his public lectures at Edinburgh. "He had (says Mr. Whiston in the Memoirs of his own life, i. 32.) already caused several of his scholars to keep acts, as we call them, upon several branches of the Newtonian philosophy; while we, at Cambridge, poor wretches, were ignominiously studying the fictitious hypothesis of the Cartesian."

In 1691, on the report of Dr. Bernard's intention of resigning the Savilian professorship of astronomy, at Oxford, our author went to London; and being patronised by Newton, and warmly befriended by Mr. Flamstead, the astronomer royal, he obtained the vacant professorship, though Dr. Halley was a competitor. This rivalship, however, instead of animosity, laid the foundation of friendship between these eminent men; and Halley soon after became the colleague of Gregory, by obtaining the Professorship of Geometry in the same university. Soon after his arrival in London, Mr. Gregory had been elected a Fellow of the Royal Society; and previously to his election into the Savilian Professorship, had the degree of Doctor of Physic conferred on him by the university of Oxford.

In 1693, he published in the Philos. Trans. a solution of the Florentine problem, "De Testudine veliformi quadrabili;" and he continued to communicate to the public, from time to time, many ingenious mathematical papers by the same channel.

1695, he printed at Oxford, "Catoptricæ et Dioptricæ Sphæricæ Elementa," a work which we are informed, in the preface, contains the substance of some of his public lectures read at Edinburgh eleven years before. This valuable treatise was republished in English, first with additions by Dr. William Brown, with the recommenda-

tion of Mr. Jones and Dr. Desaguliers, and afterwards by the latter of these gentlemen; with an appendix, containing an account of the Gregorian and Newtonian telescopes, together with Mr. Hadley's tables for the construction of both those instruments. It is not unworthy of remark, that, in the conclusion of this treatise, there is an observation which shows that the construction of achromatic telescopes, which Mr. Dolland has carried to such great perfection, had occurred to the mind of David Gregory, from reflecting on the admirable contrivance of nature in combining the different humours of the eye. The passage is as follows: "Perhaps it would be of service to make the object lens of a different medium, as we see done in the fabric of the eye; where the crystalline humour (whose power of refracting the rays of light differs very little from that of glass) is by nature, who never does any thing in vain, joined with the aqueous and vitreous humours (not differing from water as to their power of refraction) in order that the image may be painted as distinct as possible upon the bottom of the eye."

In 1702, our author published at Oxford, in folio, "Astronomiæ Physicæ et Geometricæ Elementa," a work which is accounted his master-piece. It is founded on the Newtonian doctrines, and was esteemed by Newton himself as a most excellent explanation and defence of his philosophy. In the following year he gave to the world an edition, in folio, of the works of Euclid in Greek and Latin; being done in prosecution of a design of his predecessor Dr. Bernard, of printing the works of all the ancient mathematicians. In this work, which contains all the treatises that have been attributed to Euclid, Dr. Gregory has been careful to point out such as he found reason, from internal evidence, to believe to be the productions of some inferior geometrician. In prosecution of the same plan, Dr. Gregory engaged soon after, with his colleague Dr. Halley, in the publication of the conics of Apollonius; but he had proceeded only a little way in the undertaking, when he died at Maidenhead, in Berkshire, in 1710, being the 49th year of his age.

Besides those works published in our author's life-time, as mentioned above, he had several papers inserted in the Philos. Trans. vol. xviii, xix, xxi, xxiv, and xxv, particularly a paper on the Catenarian curve, first considered by our author.

He left also, in manuscript, a short Treatise of the Nature and Arithmetic of Logarithms, which is printed at the end of Keill's translations of Commandine's Euclid; and a treatise of Practical Geometry, which was afterwards translated, and published in 1745, by Mr. Maclaurin.

Dr. David Gregory married, in 1695, Elizabeth the daughter of Mr. Oliphant, of Langtown in Scotland. By this lady he had four sons, of whom, the eldest, David, was appoined Regius Professor of modern history, at Oxford, by King George the First, and died at an advanced age in 1767, after enjoying, for many years, the dignity of Dean of Christ Church in that University.

When David Gregory quitted Edinburgh, he was succeeded in the Professorship of that University by his brother James, likewise an eminent mathematician, who held that office for thirty-three years, and retiring in 1725, was succeeded by the celebrated Maclaurin. A daughter of this Professor James Gregory, a young lady of great beauty and accomplishments, was the victim of an unfortunate attachment, that furnished the subject of Mallet's well-known ballad of William and Margaret.

Another brother, Charles, was created Professor of Mathematics at St. Andrew's, by Queen Anne, in 1707. This office he held with reputation and ability for thirty-two years; and resigning in 1739, was succeeded by his son, who eminently inherited the talents of his family, and died in 1763.

GRENADE, or GRENADO, in military affairs, a kind of small bomb or shell, being furnished with a touch-hole and fuse, and is thrown by hand from the tops, hence they are frequently styled hand-grenades. The best way to secure one's-self from the effects of a grenade, is to lie flat down on the ground before it bursts.

The grenades are of much later invention and use than the bomb. They are usually about three inches in diameter, and weigh near three pounds. The metal may be one quarter or three-eighths of an inch thick, and the hole about one-sixth.

GREWIA, in botany, so named in honour of Nehemiah Grew, M. D. F. R. S. the famous author of the "Anatomy of Vegetables," a genus of the Gynandria Polyandria class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: calyx five-leaved; petals five, with a nectareous scale at the base of each; berry four-celled. There are thirteen species.

GRIAS, in botany, a genus of the Po-

lyandria Monogynia class and order. Natural order of Guttiferæ, Jussieu. Essential character: corolla four-petalled; calyx four-cleft; stigma sessile, cross-shaped; drupe with an eight-furrowed nucleus. There is but one species, *viz.* G. cauliflora, anchovy-pear. This tree is about fifty feet in height, branching at the top; leaves on short petioles, pendulous, two or three feet long; flowers from the stem, on short, scaly, many-flowered peduncles. The uprightness of the growth, and the size of the leaves, give this tree a very elegant appearance. The fruit is nearly as large as an alligator's egg, resembling it very much in shape, but of a brown colour; they pickle the fruit, and eat it in the same manner with the East Indian mango, which it resembles in flavour. This beautiful tree is common in many parts of Jamaica, growing generally in low moist places.

GRIELUM, in botany, a genus of the Decandria Pentagynia class and order. Natural order of Gruinales. Essential character: calyx five-cleft; petals five; filament permanent; pericarpium five, with one seed in each. There is only one species, *viz.* G. tenuifolium, a native of the Cape of Good Hope.

GRIFFON, in heraldry, an imaginary animal, feigned by the ancients to be half eagle and half lion; by this form they intended to give an idea of strength and swiftness joined together, with an extraordinary vigilance in guarding the things intrusted to its care. Thus the heathen naturalists persuaded the ignorant, that gold mines were guarded by these creatures with incredible watchfulness and resolution.

GRINDERS. See ANATOMY.

GRINDING, the reducing hard substances to fine powders, either by the mortar, or by way of levigation upon a marble.

GRIPE, in the sea-language, is a piece of timber fayed against the lower piece of the stern, from the fore-mast end of the keel, joining with the knee of the head: its use is to defend the lower part of the stern from any injury; but it is often made the larger, to make the ship keep a good wind.

GRIPE is also a sea-term, for a ship's turning her head more to the wind than she should; this is caused either by overloading her a-head, the weight of which presses her down, so that she will not readily fall off from the wind; or by staying or setting her masts too much aft: which is always a fault in short ships that draw much water, since it causes them to be continually running into the wind: though in floating ships, if the masts be not stayed very far aft, they will never keep a good wind.

GRISLEA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Salicariæ, Jussieu. Essential character: calyx four-cleft; petals four, from the incisures of the calyx; filaments, very long, ascending; capsule globular, superior, one-celled, containing many seeds. There are two species, *viz.* G. secunda and G. tomentosa, the latter is a beautiful flowering shrub, a native of the hills and valleys through the northern provinces of the Carnatic in the East Indies.

GRIT, a genus of argillaceous earths, with a texture more or less porous, equable and rough to the touch. It neither gives fire with steel, nor effervesces with acids. When fresh and breathed on, it exhales an earthy smell. Its specific gravity varies from 2.0 to 2.6 and is used for mill-stones and whet-stones, and sometimes for filtering-stones and building.

GROMETS, in the sea-language, small rings formerly fastened with staples to the yards, to make fast the gaskets, but now never used.

GRONOVIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Cucurbitaceæ. Essential character: petals five, together with the stamens inserted into the bell-shaped corolla; berry dry, inferior, containing one seed. There is but one species, *viz.* G. scandens, climbing gronovia, an annual plant; sending out many trailing branches like those of the cucumber, closely set with broad leaves, which have a strong smell. Peduncles many flowered, axillary.

GROSS, in law-books, signifies absolute or independent on another: thus, an advowson in gross, is one distinct and separate from the manor.

GROSS BEAK, the English name of a bird called by authors loxia. See LOXIA.

GROSS *weight*, the whole weight of merchandizes, with their dust and dross: as also the bag or chest wherein they are contained. An allowance is usually made out of the gross-weight for tare and tret. See TARE.

GROTTO, a large deep cavern or den in a mountain or rock. Okey-hole, Eldenhound, Peake's-hole, and Pool's-hole, are famous among the natural caverns or grottos of our country. The entrance to Okey-hole, on the south side of Mendip-

hills, is in the fall of those hills, which is beset all about with rocks, and has near it a precipitate descent of near twelve fathoms deep, at the bottom of which there continually issues from the rocks a considerable current of water. The naked rocks above the entrance show themselves about thirty fathoms high, and the whole ascent of the hill above is about a mile, and is very steep. As you pass into this vault, you go at first upon a level, but advancing farther, the way is found to be rocky, and uneven, sometimes ascending, and sometimes descending. The roof of this cavern, in the highest part, is about eight fathoms from the ground, but in many particular places it is so low, that a man must stoop to get along. The breadth is not less various than the height, for in some places it is five or six fathoms wide, and in others not more than one or two. It extends itself in length about two hundred yards. People talk much of certain stones in it, resembling men and women, and other things; but there is little matter of curiosity in these, being only shapeless lumps of a common spar. At the farthest part of the cavern there is a good stream of water, large enough to drive a mill, which passes all along one side of the cavern, and at length slides down about six or eight fathoms among the rocks, and then passing through the clefts of them, discharges itself into the valley. The river within the cavern is well stored with eels, and has some trout in it; and these cannot have come from without, there being so great a fall near the entrance. In dry summers, a great number of frogs are seen along this cavern, even to the farthest part of it; and on the roof of it, at certain places, hang vast numbers of bats, as they do in almost all caverns, the entrance of which is either level, or but slightly ascending or descending; and even in the more perpendicular ones they are sometimes found, provided they are not too narrow, and are sufficiently high. The cattle that feed in the pastures through which this river runs have been known to die suddenly sometimes after a flood; this is probably owing to the waters having been impregnated, either naturally or accidentally, with lead ore.

Elden-hole is a huge profound perpendicular chasm, three miles from Buxton, ranked among the natural wonders of the Peak. Its depth is unknown, as it is pretended to be unfathomable.

Peak's-hole, and Pool's-hole, are two remarkable horizontal cavities under mountains; the one near Castleton, the other just by Buxton. They seem to have owed their origin to the springs, which have their current through them; when the water had forced its way through the horizontal fissures of the strata, and had carried the loose earth away with it, the loose stones must fall down of course: and where the strata had few or no fissures, they remained intire; and so formed these very irregular arches, which are now so much wondered at. The water which passes through Pool's-hole is impregnated with particles of limestone, and has incrusted the whole cavern in such a manner that it appears as one solid rock.

Grotto del Cani, is a little cavern near Pozzuoli, four leagues from Naples, the air contained in it, is of a mephitical or noxious quality; it is in truth carbonic acid gas, whence also it is called Bocca Venenosa, the poisonous mouth. "Two miles from Naples (says Dr. Mead,) just by the Lago de Agnano, is a celebrated mofeta, commonly called la Grotta del Cani, and equally destructive to all within the reach of its vapours. It is a small grotto about eight feet high, twelve long, and six broad; from the ground arises a thin, subtile, warm fume, visible enough to a discerning eye, which does not spring up in little parcels here and there, but in one continued stream, covering the whole surface of the bottom of the cave; having this remarkable difference from common vapours, that it does not, like smoke, disperse itself into the air, but quickly after its rise falls back again, and returns to the earth; the colour of the sides of the grotto being the measure of its ascent: for so far it is of a darkish-green, but higher, only common earth. And as I myself found no inconvenience by standing in it, so no animal, if its head is above this mark, is the least injured. But when, as the manner is, a dog, or any other creature, is forcibly kept below it; or, by reason of its smallness, cannot hold its head above it, it presently loses all motion, falls down as dead, or in a swoon; the limbs convulsed and trembling, till at last no more signs of life appear than a very weak and almost insensible beating of the heart and arteries; which, if the animal is left a little longer, quickly ceases too, and then the case is irrevocable; but if it is snatched out and laid in the open air, it soon comes to life again, and sooner if thrown into the adjacent lake."

Grotto is also used for a small artificial

edifice made in a garden, in imitation of a natural grotto.

The outsides of these grottos are usually adorned with rustic architecture, and their inside with shell-work, coral, &c. and also furnished with various fountains, and other ornaments.

The following is recommended as a good cement for grotto-work. Take two parts of white resin, melt it clear, add to it four parts of bees-wax; when melted together, add some flower of the stone you design to cement, two or three parts, or so much as will give the cement the colour of the stone; to this add one part of the flower of sulphur: first incorporate all together over a gentle fire, and afterwards knead it with your hands in warm water. With this fasten the stones, shells, &c. after they are well dried, and warmed before the fire.

GROUND, in painting, the surface upon which the figures and other objects are represented. See PAINTING.

GROUP, in painting and sculpture, is an assemblage of two or more figures of men, beast, fruits, or the like, which have some apparent relation to each other.

Groups, with respect to the design, are combinations of several figures, which bear a relation to each other, either upon account of the action, or of their proximity, or of the effect they produce. These we conceive as representing so many different subjects, or at least so many distinct parts or members of one great subject. Thus, in architecture, we say a group of columns, when we speak of three or four columns standing together on the same pedestal.

Groups, with respect to the clair-obscure, are assemblages of figures, where the lights and shadows are diffused in such a manner, that they strike the eye together, and naturally lead it to consider them in one view.

GROUP, in music, one of the kinds of diminutions of long notes, which, in working, form a sort of group, knot, or bush. It usually consists of four or more crotchets, quavers, &c. tied together at the discretion of the composer.

GRUB, the name of worms produced from the eggs of beetles, which are at length transformed into winged insects of the same species with their parents.

GROUSE, a species of the TETRAO, which see.

GRUINALES, in botany, the name of the fourteenth order of Linnæus's Fragments. This order furnishes both herbaceous and woody plants. The roots are sometimes fibrous, and sometimes tuberous. In some species of the oxalis, wood-sorrel, they are jointed; the stems are cylindric, and the young branches in some nearly square; the buds are of a conic form, covered with scales; the leaves in some genera are simple, in others compound; the flowers are hermaphrodite; the calyx consists either of five distinct leaves, or of one leaf divided almost to the bottom into five parts; it generally accompanies the seed-bud to its maturity: the petals are five, spreading, and are frequently funnel-shaped; there are generally ten stamens, the anthers oblong, and frequently attached to the filaments by the middle; the seed-vessel is commonly a five-cornered capsule, with one, three, five, or ten cells, with one seed in each cell. In this order are the geranium, crane's-bill; linum, flax; oxalis, wood-sorrel; guiacum, lignum-vitæ.

GRUS, the *crane*. See ARDEA.

GRYLLO *talpa*, the *mole-cricket*, a species of gryllus, with the anterior feet palmated. See the next article.

GRYLLUS, in natural history, the *locust*, *grasshopper*, and *cricket*, a genus of insects belonging to the order Hemiptera. Generic character: head inflected, armed with jaws, and furnished with feelers; antenna, in most species, either filiform or setaceous; wings four, deflex, convoluted; lower wings pleated; hind legs formed for leaping; claws double on all the feet. There are sixty-one species, of which the following are most worthy of notice: 1. Among the most numerous species is the gryllus migratorius of Linnæus, or common migratory locust, which of all the insects capable of injuring mankind seems to possess the most dreadful powers of destruction. Legions of these animals are from time to time observed in various parts of the world, where the havock they commit is almost incredible: whole provinces are in a manner desolated by them in the space of a few days, and the air is darkened by their numbers: nay, even when dead, they are still terrible; since the putrefaction arising from their inconceivable number is such that it has been regarded as as one of the probable causes of pestilence in the eastern regions. This formidable locust is generally of a brownish colour, varied with pale red, or flesh-colour, and the legs are frequently bluish. In the year 1748, it appeared in irregular flights in several parts of Europe, as in Germany,

France, and England; and in the capital itself, and its neighbourhood, great numbers were seen: they perished, however, in a short time, and were happily not productive of any material mischief, having been probably driven by some irregular wind out of their intended course, and weakened by the coolness of our climate. The ravages of locusts in various parts of the world, at different periods, are recorded by numerous authors. In the year 593 of the Christian era, after a great drought, these animals appeared in such vast legions as to cause a famine in many countries. In 677, Syria and Mesopotamia were overrun by them. In 852, immense swarms took their flight from the eastern regions into the west, flying with such a sound that they might have been mistaken for birds: they destroyed all vegetables, not sparing even the bark of trees and the thatch of houses; and devoured the corn so rapidly as to destroy, on computation, a hundred and forty acres in a day: their daily marches, or distances, of flight were computed at twenty miles; and these were regulated by leaders or kings, who flew first and settled on the spot which was to be visited at the same hour the next day by the whole legion: these marches were always undertaken at sun-rise. The locusts were at length driven, by the force of winds, into the Belgic Ocean, and being thrown back by the tide and left on the shores, caused a dreadful pestilence by their smell. In 1271, all the corn-fields of Milan were destroyed; and in the year 1339, all those of Lombardy. In 1541, incredible hosts afflicted Poland, Wallachia, and all the adjoining territories, darkening the sun with their numbers, and ravaging all the fruits of the earth.

2. One of the largest species of locust yet known is the gryllus cristatus of Linnæus, which is five or six times the size of the gryllus migratorius; and, together with some others of the larger kind, is made use of in various parts of the world as an article of food. The gryllus cristatus is a highly beautiful animal; being of a bright red, with the body annulated with black, and the legs varied with yellow; the upper wings tesselated with alternate variegations of dark and pale green; the lower with transverse undulated streaks; the length of the animal from head to tail is about four inches; and the expanse of wings from tip to tip, when fully extended, hardly less than seven inches and a half.

3. The gryllus viridissimus of Linnæus, is one of the largest European species, and is often seen during the decline of summer in our own country. It is wholly of a pale grass-green, with a slight blueish cast on the head and under part of the thorax, which is marked above by a longitudinal reddish-brown line; the length of the insect from the mouth to the tips of the wings is about two inches and a half: the female is distinguished by a long sword-shaped process at the end of the body, being the instrument with which she pierces the ground in order to deposit her eggs; it consists of a pair of valves, through the whole length of which the eggs are protruded; they are of an oblong form, and of a pale brown colour.

4. The gryllus gryllotalpa, or mole-cricket, is by far the most curious; and in its colour and manners differs greatly from the rest. It is of an uncouth and even formidable aspect, measuring more than two inches in length, and is of a broad and slightly flattened shape, of a dusky brown colour, with a ferruginous cast on the under parts, and is readily distinguished by the extraordinary structure of its fore-legs, which are excessively strong, and furnished with very broad feet, divided into several sharp claw-shaped segments, with which it is enabled to burrow under ground in the manner of a mole; the lower wings, which when expanded are very large, are, in their usual state, so complicated under the very short and small upper wings, or sheaths, that their ends alone appear reaching, in a sharpened form, along the middle of the back; the abdomen is terminated by a pair of sharp pointed, lengthened, hairy processes, nearly equalling the length of the antennæ in front, and contributing to give this animal an appearance, in some degree, similar to that of a blatta. The mole-cricket emerges from its subterraneous retreats only by night, when it creeps about the surface, and occasionally employs its wings in flight. It prepares for its eggs an oval nest, measuring about two inches in its longest diameter; the eggs are about two hundred and fifty or three hundred in number, nearly round, of a deep brownish-yellow colour, and of the size of common shot: on the approach of winter, or any great change of weather, these insects are said to remove the nest, by sinking it deeper, so as to secure it from the power of frost; and when the spring commences again raising it in proportion to the warmth of the season, till at length it is brought so near the sur-

face as to receive the full influence of the air and sun shine; but should unfavourable weather again take place, they again sink the precious deposit, and thus preserve it from danger. The young at their first exclusion are about the size of ants, for which, on a cursory view, they might be mistaken; but on a close inspection are easily known by their broad feet, &c. In about the space of a month they are grown to the length of more than a quarter of an inch; in two months, upwards of three quarters; and in three months, to the length of more than an inch. Of this length they are usually seen during the close of autumn, after which they retire deep beneath the surface; not appearing again till the ensuing spring. During their growth they cast their skin three or four times. The mole-cricket lives entirely on vegetables, devouring the young roots of grasses, corn, and various esculent plants, and commits great devastation in gardens.

5. G. tettigonia, or grasshopper, well known in our meadows, belongs to this genus.

GUAIACUM, in botany, a genus of the Decandria Monogynia class and order. Natural order of Gruinales. Rutaceæ, Jussieu. Essential character: calyx five-cleft, unequal; petals five, inserted into the receptacle; capsule angular, five-celled. There are four species. From the G. officinale, is obtained a resin which exudes spontaneously, and is also driven out artificially by means of heat. This substance has been long known and celebrated as a medicine in various cases; and in the Transactions of the Royal Society for the year 1806, we have a very complete analysis of it: by distillation 100 parts yielded

Acidulous water	5.5
Thick brown oil	24.5
Thin empyreumatic oil	29.0
Charcoal	30.5
Gases consisting of carbonic acid and carbureted hydregen	10.5
	100.0

Hence it is inferred that guaiacum agrees in many respects with the resins, but it differs from them, 1. in the quantity of charcoal it leaves when distilled in close vessels; 2. in the action that nitric acid has upon it; and, 3. in the changes of colour that it undergoes when its solutions are treated with nitric and oxymuriated acids. Its properties may be thus enumerated: it is a solid substance resembling a resin; its colour varies, but is generally greenish; it is readily dissolved in alcohol; alkaline solutions dissolve it with ease: most of the acids act upon it with considerable energy; if digested in water, a portion is dissolved, the water acquiring a greenish-brown colour: the liquid being evaporated, leaves a brown substance which possesses the properties of an extract, being soluble in hot water and alcohol, but scarcely at all in sulphuric ether, and forming precipitates with the muriates of alumina, tin, and silver.

GUANA. See LACERTA.

GUANO, a substance found on many of the small islands in the South Sea, which are the resort of numerous flocks of birds, particularly of the Ardea and Phænicopterus genus. It is dug from beds fifty or sixty feet thick, and used as a valuable manure in Peru, chiefly for Indian corn. It is of a dirty yellow colour, nearly insipid to the taste, but has a powerful smell, partaking of castor and valerian. According to the analysis of Fourcroy and Vauquelin, about one-fourth of it is uric acid, partly saturated with ammonia and lime. It contains likewise oxalic acid, partly saturated with ammonia and potash; phosphoric acid combined with the same bases and with lime; small quantities of sulphate and muriate of potash and ammonia; a small portion of fat matter; and sand, partly quartzose, partly ferruginous.

GUARD, in a general sense, signifies the defence or preservation of any thing; the act of observing what passes, in order to prevent surprise; or the care, precaution, and attention we make use of, to prevent any thing happening contrary to our intention or inclinations.

GUARD, in the military art, is a duty performed by a body of men, to secure an army or place from being surprised by an enemy.

In a garrison the guards are relieved every day, and it comes to every soldier's turn once in three days, so that they have two nights in bed, and one upon guard. To be upon guard, to mount the guard, to dismount the guard, to relieve the guard, to change the guard, the officer of the guard, or the serjeant of the guard, are words often used, and well understood.

GUARD, *advanced*, is a party of either horse or foot, that marches before a more

considerable body, to give notice of any approaching danger.

When an army is upon the march, the grand guards which should mount that day serve as an advanced guard to the army: in small parties six or eight horse are sufficient, and these are not to go above four or five hundred yards before the party.

An advanced guard is also a small body of twelve or sixteen horse, under a corporal or quarter-master, posted before the grand guard of a camp.

Guard, *artillery*, is a detachment from the army, to secure the artillery: their corps de garde is in the front, and their centries round the park. This is a forty-eight hours guard: and upon a march they go in the front and rear of the artillery, and must be sure to leave nothing behind. If a gun or waggon break down, the captain is to leave a part of his guard to assist the gunners and matrosses in getting it up again.

Guard, *main*, that from whence all the other guards are detached.

Those who are to mount the guard meet at their respective captain's quarters, and go from thence to the parade; where, after the whole guard is drawn up, the small guards are detached for the posts and magazines; and then the subaltern officers throw lots for their guards, and are commanded by the captain of the main guard.

Guard, *piquet*, a good number of horse and foot always in readiness in case of an alarm: the horse are all the time saddled, and the riders booted. The foot draw up at the head of the battalion, at the beating of the tattoo; but afterwards return to their tents, where they hold themselves in readiness to march upon any sudden alarm. This guard is to make resistance, in case of an attack, till the army can get ready.

Guard *boat*, a boat appointed to row the rounds among the ships of war in any harbour, to observe that their officers keep a good look-out, calling to the guard-boat as she passes, and not suffering her crew to come on board, without having previously communicated the watch-word of the night.

Guard *irons*, are curved bars of iron placed over the ornamental figures on a ship's head or quarter, to defend them from injury.

Guard *ship*, a vessel to superintend the marine affairs in a harbour or river, and to see that the ships which are not commissioned have their proper watch duly kept; she is also to receive seamen who are impressed in time of war: she generally has an admiral's flag at one of her masts head.

Guard, in fencing, is a posture proper to defend the body from an enemy's sword.

There are four general guards of the sword; to form a perfect idea of which, we must suppose a circle drawn on a wall, and divided into four cardinal points, *viz.* top and bottom, right and left. When the point of the sword is directed to the bottom of the circle, with the hilt opposite to its top, the body inclining very forward, this is called the prime or first guard. The second guard, by many improperly called the tierce, is when the point is directed to the right or second point of the same circle, with the hilt of the sword turned to the left, and the body proportionably raised. The tierce, or third guard, is when the point of the sword is raised to the uppermost part of the same circle; in which case the body, the arm, and the sword, are in their natural position, and in the mean of the extremes of their motion. The quart, or fourth guard, is when the point of the sword is directed to the fourth point of the circle, descending to the right as far as one fourth of the tierce, with the outward part of the arm and the flat of the sword turned towards the ground, and the body out of the line to the right, and the hilt of the sword towards the line to the left. There is also a quint, or fifth guard, which is only the return of the point of the sword to the right, after traversing the circle to the point of the prime, from whence it had departed, with a different disposition of the body, arm, and sword. The common centre of all those motions ought to be in the shoulder.

In all these kinds of guards there are the high-advanced, high-retired, and high-intermediate guard, when disposed before the upper part of the body, either with the arm quite extended, quite withdrawn, or in a mean state. The mean-advanced guard, or simply mean guard, is when the sword is placed before the middle part of the body. The low-advanced, retired, or intermediate guards, are those where the arm and sword are advanced, withdrawn, or between the two extremes, before the lower part of the body.

GUARDIAN, in law. A guardian is one appointed to take care of a person and his affairs, who by legal imbecility and want of understanding is incapable of acting for his own interest; and it seems by our law,

that his office originally was to instruct the ward, under the feudal tenures, in the arts of war, as well as those of husbandry and tillage, that when he came of age, he might be the better able to perform those services to his lord, whereby he held his own land.

There are several kinds of guardians, as, guardian by nature, guardian by the common law, guardian by statute, guardian by custom, guardian in chivalry, guardian in socage, and guardian by appointment of the Lord Chancellor.

Guardian by nature, is the father or mother; and by the common law every father hath a right of guardianship of the body of his son and heir, until he attains to the age of twenty-one years. This guardianship extends no further than the custody of the infant's person. The father may disappoint the mother, and other ancestors, of the guardianship by nature, by appointing a testamentary guardian under the statutes 4 and 5 Phil. and Mary, and 12 Char. II. A guardian by nature hath only the care of the person and education of the infant, and hath nothing to do with his lands, merely in virtue of his office; for such guardian may be, though the infant have no lands at all, which a guardian in socage cannot.

Guardian, by the common law, or *Guardian in Socage.* If a tenant in socage die, his heir being under fourteen, whether he be his issue or cousin, male or female, the next of blood to the heir, to whom the inheritance cannot descend, shall be guardian of his body and land till fourteen; and although the nature of socage tenure is in some measure changed from what it originally was, yet it is still called socage tenure, and the guardian in socage is still only where lands of that kind, as most of the lands in England now are, descend to the heir within age; and though the heir after fourteen may choose his own guardian, who shall continue till he is twenty-one, yet as well the guardian before fourteen, as he whom the infant shall think fit to choose after fourteen, are both of the same nature, and have the same office, without any intervention or direction of the infant himself; they are to transact all affairs in their own name, and not in the name of the infant, which they would be obliged to do, if their authority were derived from him.

This guardianship is so little resorted to, although all lands are now of socage tenure, that it is needless to enquire further into it here.

Guardian *by statute,* or *Testamentary Guardian.* By the common law, no person could appoint a guardian, because the law had appointed one, whether the father were tenant by knight service, or in socage.

The first statute that gave the father a power of appointing, was the 4 and 5 Philip and Mary, c. 8, which provides, under severe penalties, such as fine and imprisonment for years, against taking any maid, or woman child unmarried, being within the age of sixteen years, out of or from the possession, custody, or governance, and against the will of the father of such maid, or woman child, or of such person or persons, to whom the father of such maid, or woman child, by his last will and testament, or by any other act in his life time, shall grant the education and governance of such child.

But the principal guardianship is now by the statute 12 Charles II. c. 24, by which any father, under or of full age, may by deed or will, attested by two witnesses, appoint, dispose of the custody of his child born or unborn to any person except a popish recusant convict, either in possession or reversion till such child attain twenty-one. This guardian supersedes the guardian in socage, and has all actions which that guardian might have had. Besides which he has the care of the estate, real and personal. A father cannot under this statute appoint one to his natural child, and a case has been decided upon the marriage act, in which a marriage with consent of a guardian applied to a natural child was held void. The chancellor, however, will upon application appoint the same person guardian.

Guardians by custom, are appointed in the City of London, in the county of Kent, and with respect to copyhold lands in some manors.

Guardians by appointment of the ecclesiastical court, were appointed to take care of the infant's personal estate, till fourteen in males, and twelve in females; but their authority over the person is now denied, and they are only confined to guardianship for the purpose of a suit in an ecclesiastical court.

Guardian, in chivalry, is obsolete, but extended to twenty-one years.

Guardian, by appointment of the Lord Chancellor. It is not easy to state how this jurisdiction was acquired; for it is certainly of no very ancient date, though

now indisputable; for it is clearly agreed, that the king, as pater patriæ, is universal guardian of all infants, idiots, and lunatics, who cannot take care of themselves, and as this care cannot be exercised otherwise than by appointing them proper curators or committees, it seems also agreed, that the king may, as he has done, delegate the authority to his chancellor: and that therefore at this day the Court of Chancery is the only proper court, that hath jurisdiction in appointing and removing guardians, and in preventing them and others from abusing their persons or estates. And as the Court of Chancery is now vested with this authority, hence in every day's practice we find that court determining, as to the right of guardianship, who is the next of kin, and who the most proper guardian; as also orders are made by that court on petition or motion, for the provision of infants during any dispute therein; as likewise guardians removed or compelled to give security; they and others punished for abuses committed on infants, and effectual care taken to prevent any abuses intended them in their persons or estates; all such wrongs and injuries being reckoned a contempt of that court, that hath, by an established jurisdisction, the protection of all persons under natural disabilities. All courts of justice appoint guardians to infants, to see and prosecute their rights in their respective courts, when the occasion calls for it.

There are also some cases where an infant may elect a guardian, and the Court of Chancery allows him to do so after fourteen.

GUARDIAN *of the Spiritualties*, is he to whom the spiritual jurisdiction of any diocese is committed, during the vacancy of the see. The archbishop is guardian of the spiritualties, on the vacancy of any see within his province; but when the archiepiscopal see is vacant, the dean and chapter of the archbishop's diocese are guardians of the spiritualties.

GUAREA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Meliæ, Jussieu. Essential character: calyx four-cleft; petals four; nectary cylindric, bearing the anthers at its mouth; capsule four-celled, four-valved; seeds solitary. There is only one species, *viz.* G. trichilioides, ash-leaved guarea. This tree is remarkable for its strong odour of musk, particularly the bark, and is used instead of that perfume for many purposes. The wood is full of a bitter resinous substance, which renders it unfit for rum hogsheads, having been observed to communicate both its smell and taste to spirituous liquors. It is a native of South America and the West India islands. The English call it muskwood.

GUDGEONS, in a ship, are the eyes drove into the stern-post, into which the pintles of the rudder go, to hang it.

GUERICKE, OTTO, or OTHO, a very eminent German experimental philosopher in the seventeenth century, who, with Torricelli, Pascal, and Boyle, greatly contributed to explain the various properties of the air and their effects, was born in the year 1602, and died, at Hamburgh, in the year 1686. He was councellor to the Elector of Brandenburg; and burgomaster, or consul, of Magdeburg; but his memory derives greater honour from his philosophical discoveries, than from the civil dignities to which he was raised. To him is to be attributed the invention of the air-pump, for though Mr. Boyle had, about the same time, made some approaches towards a similar discovery, yet he ingenuously acknowledged in a letter to his nephew, Lord Dungarvon, that the information which he received from Schottus's "Mechanica Hydraulico Pneumatica," published in 1657, in which was an account of Guericke's experiments, first enabled him to bring his design to any thing like maturity. Guericke was also the inventor of the two brass hemispheres, to illustrate the pressure of the air, which, being applied to each other, and the air exhausted, resisted the force of sixteen horses to draw them asunder. He likewise invented an instrument to show the variations in the state of the atmosphere, consisting of a tube, in which was a little image of glass, that descended in rainy or stormy weather, and rose again when the weather became fine and serene. This last machine fell into disuse on the invention of the barometer, and especially after the improvements made in that instrument by Huygens and Amontons. By consulting his tube, Guericke would frequently foretel approaching storms; whence the ignorant populace gave him the character of a sorcerer. In this opinion of him they were confirmed by a thunder storm discharging itself one day upon his house, and shivering to pieces several machines of which he had made use in his experiments. That event they considered to be an unequivocal indication of the anger of Heaven, and a just punishment inflicted

upon him for his impiety. He was the author of several treatises in natural philosophy, the principal of which is entitled "Experimenta Magdeburgica," 1672, folio, and contains his experiments on a vacuum.

GUETTARDA, in botany, a genus of the Monoecia Heptandria class and order. Natural order of Tricoccæ. Rubiaceæ, Jussieu. Essential character: calyx cylindric; corolla six or seven-cleft, funnel-shaped; pistil one; drupe dry. There are four species, natives of the East and West Indies.

GUGLIELMINI (Dominic), an eminent Italian mathematician and civil engineer, was descended from an honourable family, and born at Bologna in the year 1655. His favourite studies were the mathematics and medicine, in the former of which he had for tutor the celebrated M. Germ. Montanari; and in the latter, the illustrious Malpighi. He entered into the dispute between M. Montanari and M. Cavina, concerning the extraordinary luminous meteor, which was observed in most parts of Italy in 1676, and supported the opinions of his master. In the year 1678 he was admitted to the degree of doctor of medicine by the university of Bologna. Upon the appearance of the remarkable comet in the years 1680 and 1681, he published a treatise "De Cometarum Natura et Ortec," &c. 1681, in which he proposed a new system on the subject, which he thought would serve to explain all the phenomena of those heavenly bodies; but it did not meet with the approbation of the scientific world. His next astronomical treatise, containing remarks on the solar eclipse which took place on the 12th of July, 1684, and which he published in Latin, at Bologna, in the same year, reflected greater credit on his knowledge and accuracy of observation. Soon afterwards the senate of Bologna appointed him principal professor of mathematics in the university of that city, and, in the year 1686, created him intendant-general of the rivers of the Bolognese. The office last mentioned engaged him to pay more particular attention to the study of hydrostatics and hydraulics; in consequence of which, in the year 1690, he published the first part, and in the following year the second part, of an excellent hydrostatical treatise, entitled "Aquarum Fluentium Mensura, Novo Methodo Inquisita." Some of his observations in this work were attacked by M. Papin, who also entered into a contest with the author on the subject of Syphons. Their difference in opinion gave rise to two letters by Guglielmini, which were printed under the title of "Epistolæ Duæ Hydrostaticæ." He was engaged in settling the differences which arose between the cities of Bologna and Ferrara respecting the management of the embankments and sluices in their contiguous districts; and received as a reward of his services, from his native city, the appointment to a new office in the university, which was that of professor of hydrometry. In the year 1695 he assisted M. Cassini in repairing the famous meridian line which he had constructed forty years before in the church of St. Petronius, at Bologna; on which occasion our author published a memoir, descriptive of the method pursued in laying it down, and establishing its claims to correctness and accuracy. In the year 1697 he published his grand physico-mathematical treatise on the nature of rivers, entitled "Della Natura de Fiumi," which raised his reputation to the highest pitch, for correct scientific knowledge, ingenuity, and judgment in hydraulics. Montucla commends it in warm terms, and says that it ought to be carefully studied by every person who would wish to become thoroughly master of this branch of science. The reputation which Guglielmini acquired by this performance, occasioned his being employed by the Dukes of Mantua, of Parma, and Modena, the Grand Duke of Tuscany, Pope Clement XI. the Republics of Venice and Lucca, &c. in the invention and construction of the necessary hydraulic works in their respective territories. In the year 1698 he was induced, by the Republic of Venice, to accept of the mathematical chair in the university of Padua; but the senate of Bologna decreed that he should still retain, notwithstanding his new employment, the title of professor in their university, and the emoluments annexed to it. In the year 1702, he exchanged his mathematical chair at Padua, for the more lucrative one of medicine; after which he published different treatises on medical and chemical subjects, &c. He died at Padua in 1710, in the fifty-fifth year of his age. He had been admitted a member of the Academy of Sciences at Paris, in the year 1696, and was also associate, or corresponding member of the Academies of Berlin and Vienna, and of the Royal Society at London. The best edition of his treatise on the nature of rivers, was published at Bologna in 1756,

with the notes of Manfredi; and the whole of his works were printed in a collective form at Geneva, in 1719, in two volumes quarto.

GUIAC. See Resin.

GUIDE, in music, the name given to that note in a fugue which leads off and announces the subject.

GUILANDINA, in botany, *bonduc* or *nicker-tree*, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx one-leafed; salver-shaped; petals inserted into the neck of the calyx, nearly equal; seed vessel a legume. There are six species.

GUILD, or Gild, a fraternity or company. As to the original of these guilds or companies, it was a law among the Saxons that every freeman of fourteen years of age should find sureties to keep the peace, or be committed; upon which the neighbours entered into an association, and became bound for each other, either to produce him who committed any offence, or to make satisfaction to the injured party; in order to which they raised a sum among themselves, which they put into a common stock; out of which they, upon occasion, made a pecuniary compensation according to the quality of the offence committed. These guilds are now companies, joined together with laws and orders made by themselves, by the licence of the prince.

GUITAR. See Musical *instruments*.

GULES, in heraldry, signifies the colour red, which is expressed in engraving by perpendicular lines falling from the top of the escutcheon to the bottom.

GUM, a thick transparent tasteless fluid, which exudes occasionally from certain species of trees. It is adhesive, and gradually hardens without losing its transparency. Gum is chiefly obtained from different species of the mimosa, particularly from M. nilotica, a native of Egypt and Arabia, which is known by the name of gum arabic. The specific gravity of gum is about 1.4. It is not changed by exposure to the air, but is deprived of its colour by the action of the sun. By heat it becomes soft, and is speedily reduced to the state of charcoal, which enters largely into its composition. The constituent parts of gum are carbon, hydrogen, and oxygen, with smaller proportions of nitrogen and lime. The oxygen is much less in quantity than the saccharine matter. See Sugar. The existence of lime and nitrogen in gum renders it essentially different from fecula and sugar, to which, in other respects, it bears a near relation; they, however, are able to undergo the vinous fermentation, which is not the case with gum. Gum readily dissolves in water, and the solution, which is thick and adhesive, is known by the name of mucilage. It is soluble also in the vegetable acids. Sulphuric acid decomposes it, and converts it into water, acetic acid, and charcoal. With the assistance of heat, muriatic acid, and nitric acid, produce a similar effect. It is insoluble in alcohol and ether Such are the chief properties of gum arabic. There are, besides this, other gums, of which the principal is denominated tragacanth, from the astragalus tragacantha, a native of the island of Crete, which is in the form of vermicular masses; it is less transparent, and more adhesive than gum arabic, but by distillation it yields similar products. In our garden and orchards we find, in good quantities, gum exuding from the cherry and plumb trees, which differs chiefly from gum arabic in being softer and more soluble. Gum, in a state of mucilage, exists in a number of plants, especially in the roots and leaves. It is most abundant in bulbous roots, and of these the hyacinth seems to contain the largest quantity. A pound of the bulbs of this root, when dried, yields four ounces of a powder, which, when macerated in water, give a mucilage that acts well as a mordant for fixing the colours in calico-printing. Gum is used in medicine, and is considered as a specific against the stranguary occasioned by blisters; it constitutes, under particular forms, a nutritious food, and it is well known as an important article in the manufacture of our ink.

Gum *resins*, are certain substances that have long been used in medicine. They are all solid, generally brittle and opaque, have a strong smell, and a pungent and bitter taste. They consist chiefly of gum and resin, the proportions varying with the particular substance. They are never obtained by means of spontaneous exudation, but are procured by wounding the plants which contain them. The principal of the gum-resins are, 1. Ammoniac, which see. 2. Assafœtida, obtained from the ferula assafœtida, a plant found in Persia. The gum resin is extracted from the roots by cutting off the extremities; a milky juice flows out, which is dried in the sun. It is brought to Europe in masses; its smell is very fetid, and its taste acrid. It is par-

tially soluble in water and alcohol. 3. Euphorbium, obtained from the euphorbia officinalis, a native of Ethiopia, by making incisions in the plant. It is brought from Africa in the form of tears, is soluble in alcohol. It has no smell; after a time it communicates a burning taste to the tongue. It is regarded as poisonous. 4. GALBANUM, which see. 5. GAMBOGE, which see. 6. Myrrh, which is brought from the East Indies in the form of tears, is light, brittle, of a reddish colour, and has an unctuous feel; it is bitter and aromatic; it is soluble in water and alcohol in slight degrees. 7. Opoponax, obtained from the pastenaca opoponax, a peremial plant which grows wild in the south of Europe. This is extracted by wounding the stock or root, and is known here in the form of round drops or tears, or in irregular masses of a reddish colour. It is bitter and acrid to the taste, and with a peculiar smell. It forms a milky solution with water, and yields an essential oil by distillation. 8. Sapagenum supposed to be had from the ferula persica, and brought in large masses, or distinct tears, from Alexandria. It has a hot taste and disagreeable smell. It is moderately soluble in alcohol, but much more so in water. By distillation it yields a fœtid volatile oil. From some experiments made upon ipecacuanha, it is thought to contain a gum resin. All the gum resins that have been analysed have been found to contain ammonia.

GUN, a fire arm or weapon of offence, which forcibly discharges a ball, shot, or other offensive matter, through a cylindrical barrel, by means of gunpowder. Gun is a general name, under which are included divers, or even most species of fire arms. They may be divided into great and small.

Great guns, called also by the general name cannons, make what we also call ordnance or artillery; under which come the several sorts of cannon. See CANNON, ARTILLERY, &c.

GUN is also a name given to an instrument used by miners in cleaving rocks with gunpowder. It is an iron cylinder of an inch and a half thick, and about six inches long; and having a flat side to receive the side of a wedge; and a hole drilled through it to communicate with the inside of the hole in the rock: this hole is made about eight inches deep, and in the bottom of it is put about two or three ounces of gunpowder: then this gun is driven forcibly in, so as to fill up the hole, and the wedges is driven in on its flat side to secure it. The priming at the hole is then fired by a train, and the orifice being so well stopped by this gun, the force of the powder is determined to the circumadjacent parts of the rock, which it splits.

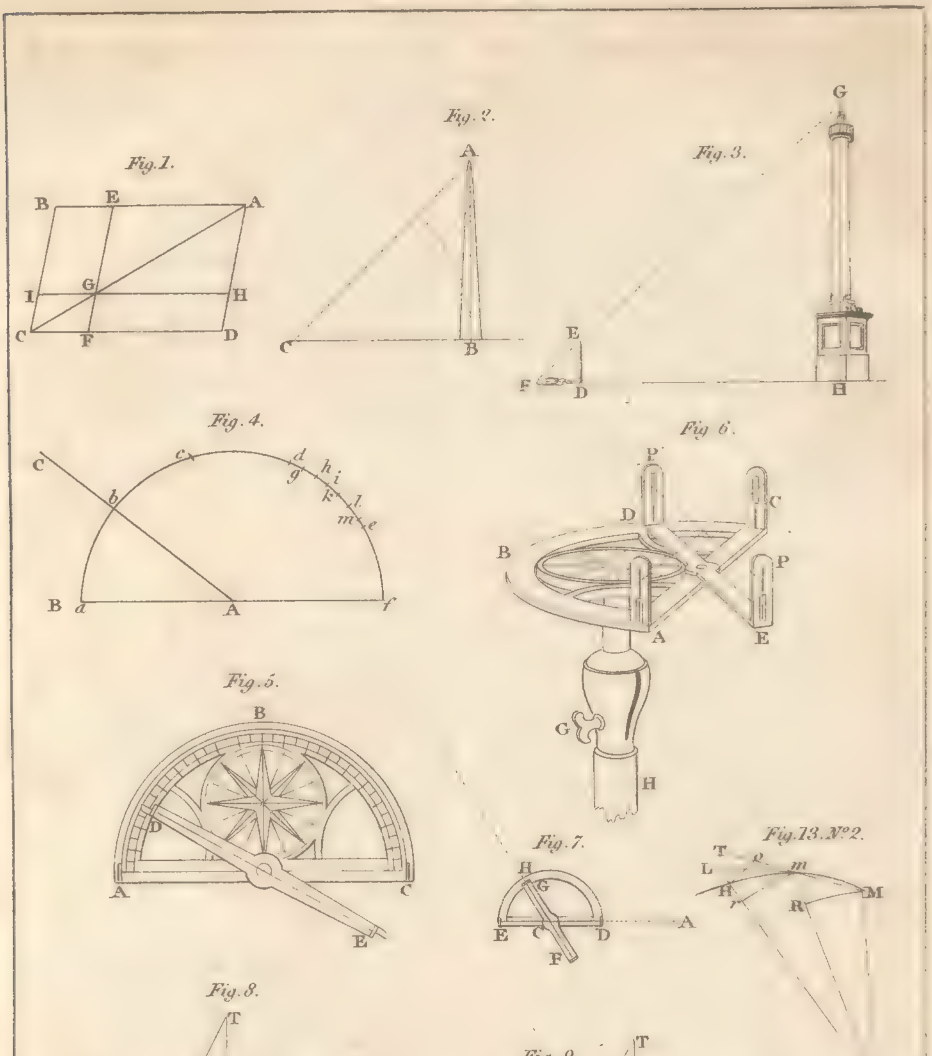
GUN *room*, in a ship, the apartment under the great cabin, where the master-gunner and his crew rendezvous, get ready their cartridges, &c. and do all things belonging to their business.

GUNDELIA, in botany, so called in honour of Dr. Andrew Gundelscheimer, who found this plant in his travels, in company with Tournefort, in the Levant; a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx scarcely any, five-flowered; corolla tubular, male and hermaphrodite; receptacle chaffy; down none. There is but one species, *viz.* G. tournefortii, a milky plant, with alternate prickly leaves; flowers terminating. It is a native of the Levant.

GUNNER, an officer appointed for the service of the cannon; or one skilled to fire the guns. In the Tower of London, and other garrisons, as well as in the field, this officer carries a field staff, and a large powder horn in a string over his left shoulder; he marches by the guns, and when there is any apprehension of danger, his field staff is armed with match; his business is to lay the gun to pass, and to help to load and traverse her.

GUNNER of a ship, or master-gunner, has the charge of all the ordnance the ship carries, to see that they be serviceably mounted, and sufficiently supplied with spunges, ladles, and rammers; that in foul weather they be traversed within board, especially those of the lower tier, and that the ports be shut, and caulked up; and that at all times they may be well lashed, and made fast, lest any of them break loose, to the imminent danger of foundering the ship. In the time of an engagement, the gunner is to see that every piece be sufficiently manned; he is answerable to give an account of all his charge upon demand. He has a mate and quarter-gunners for his assistance.

GUNNER, *master*, a patent-officer of the ordnance, who is appointed to teach all such as learn the art of gunnery, and to certify to the master-general the ability of any person recommended to be one of the King's gunners. To every scholar he administers an oath, not to serve, without leave, any other prince or state; or teach any one



J. Farey Junr. delin. *London. Published by Longman, Hurst, Rees & Orme, 1809.* *Lowry sculp.*

the art of gunnery, but such as have taken the said oath.

GUNNERA, in botany, so named in honour of J. E. Gunnerus, Bishop of Drontheim, in Norway, a genus of the Gynandria Diandria class and order. Natural order of Urticæ, Jussieu. Essential character: ament with one-flowered scales; calyx and corolla none; germ two-toothed; styles two; seed one. There is but one species, *viz.* G. perpensa, marsh marygold-leaved gunnera. Native of the Cape.

GUNNERY, is the art of determining the course and directing the motion of bodies shot from artillery, or other warlike engines.

The great importance of this art is the reason it is distinguished from the doctrine of projectiles in general; for it is no more than an application of those laws which all bodies observe when cast into the air, to such as are put in motion by the explosion of guns or other engines of that sort. And it is the same thing whether it is treated in the manner of projectiles in general, or of such only as belong to gunnery; for from the moment the force is impressed, all distinction with regard to the power which put the body first in motion is lost, and it can only be considered as a simple projectile. See PROJECTILES.

Prob. I. The impetus of a ball, and the horizontal distance of an object aimed at, with its perpendicular height or depression, if thrown on ascents or descents, being given, to determine the direction of that ball.

From the point of projection A (Plate VI. Miscell. fig. 8, 9, 10, 11,) draw A *m* representing the horizontal distance, and B *m* the perpendicular height of the object aimed at: bisect A *m* in H, and A H in *f*; on H and *f* erect H T, *f* F perpendicular to the horizon, and bisecting A B the oblique distance or inclined plane in D, and A D in F. On A raise the impetus A M at right angles with the horizon, and bisect it perpendicularly in *c*, with the line G G. Let the line A C be normal to the plane of projection A B, and cutting G G in C; from C as centre, with the radius C A, describe the circle A G M cutting if possible the line F S in S, *s*, points equally distant from G; lines drawn from A through S, *s*, will be the tangents or directions required.

Continue A S, A *s* to T, *t*; bisect D T, D *t*, in V, *v*; and draw lines from M to S, *s*; then the angle A S F = angle M A S = angle A M *s* = angle *s* A F; and for the same reason angle A *s* F = angle M A *s* = angle A M S = angle S A F; wherefore the triangles M A S, S A F, *s* A F are similar, and A M : A *s* : : A *s* : *s* F = *t v*; consequently A T is a tangent of the curve passing through the points A, *v*, and B; because *t v* = *v* D, A D is an ordinate to the diameter T H, and where produced must meet the curve to B.

In horizontal cases (fig. 10.) *v* is the highest point of the curve, because the diameter T *v* H is perpendicular to the horizon.

When the mark can be hit with two directions (the triangles S A M, *s* A F being similar) the angle which the lowest direction makes with the plane of projection is equal to that which the highest makes with the perpendicular A M, or angle *s* A F = angle S A M. And the angle S A *s*, comprehended between the lines of direction, is equal to the angle S C G, and is measured by the arch S G.

When the points S, *s* coincide with G, or when the directions A S, A *s* become A G; (fig. 11.) A B will be the greatest distance that can be reached with the same impetus on that plane; because S F coinciding with G *g* the tangent of the circle at G, will cut off A *g* a fourth part of the greatest amplitude on the plane A B. The rectangular triangle *m* A B, *c* A C are similar, because the angle of obliquity *m* A B = *c* A C; wherefore *m* A : *m* B : : one-half impetus : *c* C, and *m* A : A B : : A *c* : A C.

Horizontal Projections (ibid. fig. 10, 11.)

When the impetus is greater than half the amplitude, there are two directions, T A H, and *t* A H for that amplitude; when equal to it, only one; and when less, none at all; and conversely. For in the first case the line F S cuts the circle in two points S, *s*, in the second case it only touches it, and in the last it meets not with it at all; and conversely. When there is but one direction for the amplitude A *m*, the angle of elevation is 45°; and when the angle of elevation is of 45° A *m* is the greatest amplitude for that impetus, and equal to twice the impetus. The impetus remaining the same, the amplitudes are in proportion to one another as the signs of double the angles of elevation, and conversely. For drawing *s* N (fig. 10) parallel and equal to A F a fourth part of the amplitude, and supposing lines drawn from *s* to the points C and M, the angle A C *s* = 2 A M *s* = 2 *s* A F; therefore N *s*, the sine of A C *s* is

the sine of twice the angle s A F; half the impetus being radius.

Whence, at the directions of 15° or 75°, the amplitude is equal to the impetus; for from what has been said, half the impetus being radius, a fourth part of the amplitude is the sine of twice the angle of elevation; but the sine of twice 15°, that is, the sine of 30°, is always equal to half the radius; or in this case a fourth part of the impetus is equal to a fourth part of the amplitude. From this and the preceding proposition there are two easy practical methods for finding the impetus of any piece of ordnance. The fourth part of the amplitude is a mean proportional between the impetus at the curve's principal vertex and its altitude. For M N : N s : : N s : N A $=$ s F $=$ v D.

The altitudes are as the versed sines of double the angles of elevation, the impetus remaining the same. For making half the impetus radius, A N the altitude is the versed sine of the angle A C s $=$ twice angle s A F. And also, radius : tangent angle elevation :: one-fourth amplitude : altitude; that is, R : tangent angle s A f : : A f : f s $=$ D v.

Projections on Ascents and Descents, fig. 8, 9.

If the mark can be hit only with one direction A G, the impetus in ascents will be equal to the sum of half the inclined plane and half the perpendicular height, and in descents it will be equal to their difference; but if the mark can be reached with two directions, the impetus will be greater than that sum or difference. For when A G is the line of direction, the angle g G A being $=$ M A G $=$ G A g; G g $=$ A g, and g z added to or subtracted from both makes G z half the impetus equal to the sum or difference of A g a fourth part of the inclined plane, and g z a fourth part of the perpendicular height. In any other direction F P is greater than F o $=$ A F; and F f added to or subtracted from both, makes f P half the impetus greater than the sum or difference of A F a fourth part of the inclined plane, and F f a fourth part of the perpendicular height. Whence if in ascents the impetus be equal to the sum of half the inclined plane and half the perpendicular height, or if in descents it be equal to their difference, the mark can be reached only with one direction; if the impetus is greater than that sum or difference, it may be hit with two directions; and if the impetus is less, the mark can be hit with none at all.

Prob. II. The angles of elevation, the horizontal distance, and perpendicular height being given, to find the impetus. Fig. 8, 9.

From these data you have the angle of obliquity, and length of the inclined plane; then as

A s : A M : : S. angle A M s : S. angle A s M : : S. angle s A F : S. angle M A F, and A F : A s : : S. angle M A s : S. angle M A F; whence by the ratio of equality, A F : A M : : S. angle $\overline{s \text{ A F} \times \text{S.}}$ angle M A s : S. angle $\overline{\text{M A F} \times \text{S.}}$ angle M A F, which gives this rule.

Add the logarithm of A F to twice the logarithmic sine of the angle M A F; from their sum subtract the logarithmic sines of the angles s A F and M A s, and the remainder will give the logarithm of A M the impetus.

When the impetus and angles of elevation are given, and the length of the inclined plane is required, this is the rule. Add the logarithm of A M to the logarithmic sines of the angles s A F and M A s; from their sum subtract twice the logarithmic sine of angle M A F, and the remainder will give the logarithm of A F the fourth part of the length of the inclined plane.

If the angle of elevation t A H and its amplitude A B (fig. 11,) and any other angle of elevation t A H is given; to find the amplitude A b for that other angle, the impetus A M and angle of obliquity D A H remaining the same.

Describe the circle A G M, take A F a fourth part of A B, and A f a fourth part of A b: from the points F, f, draw the lines F s and f p parallel to A M, and cutting the circle in the points s, p; then A F : A M : : S. angle s $\overline{\text{A F} \times \text{S.}}$ angle M A s : S. angle M A $\overline{\text{F} \times \text{S. angle}}$ M A F; and A M : A f : : S. angle M A $\overline{\text{F} \times \text{S. angle}}$ M A F : S. angle p $\overline{\text{A} f \times \text{S.}}$ angle p A M; whence by the ratio of equality.

A F : A f : : S. angle s A $\overline{\text{F} \times \text{S.}}$ angle M A s : S. angle p $\overline{\text{A} f \times \text{S.}}$ angle p A M, which gives this rule.

Add the logarithm of A F to the logarithmic sines of the angles p A f, p A M; from their sum subtract the logarithmic sines of the angles s A F, s A M, and the remainder will give the logarithm of A f, a fourth part of the amplitude required.

Prob. III. To find the force or velocity of a ball or projectile at any point of the curve, having the perpendicular height of that point, and the impetus at the point of

projection given. From these two data find out the impetus at that point; then 2 × 16 feet 1 inch is the velocity acquired by the descent of a body in a second of time; the square of which (4 × the square of 16 feet 1 inch) is to the square of the velocity required, as 16 feet 1 inch is to the impetus at the point given; wherefore multiplying that impetus by four times the square of 16 feet 1 inch, and dividing the product by 16 feet 1 inch, the quotient will be the square of the required velocity; whence this rule. Multiply the impetus by four times 16 feet 1 inch, or 64 feet $\frac{1}{3}$, and the square root of the product is the velocity.

Thus suppose the impetus at the point of projection to be 3,000. and the perpendicular height of the other point 100; the impetus at that point will be 2,900. Then 2,900 feet multiplied by 64$\frac{1}{3}$ feet gives 186,566 feet, the square of 432 nearly, the space which a body would run through in one second, if it moved uniformly.

And to determine the impetus or height, from which a body must descend, so as at the end of the descent it may acquire a given velocity, this is the rule:

Divide the square of the given velocity (expressed in feet run through in a second) by 64$\frac{1}{3}$ feet, and the quotient will be the impetus.

The duration of a projection made perpendicularly upwards, is to that of a projection in any other direction whose impetus is the same, as the sine complement of the inclination of the plane of projection (which in horizontal projections is radius) is to the sine of the angle contained between the line of direction and that plane.

Draw out A t (fig. 8,) till it meets m B continued in E, the body will reach the mark B in the same time it would have moved uniformly through the line A E; but the time of its fall through M A the impetus, is to the time of its uniform motion through A E, as twice the impetus is to A E. And therefore the duration of the perpendicular projection being double the time of its fall, will be to the time of its uniform motion through A E; as four times the impetus is to A E; or as A E is to E B; that is, as A t is to t D; which is as the sine of the angle t D A (or M A B its complement to a semicircle) is the sine of the angle t A D.

Hence the time a projection will take to arrive at any point in the curve, may be found from the following data, *viz.* the impetus, the angle of direction, and the inclination of the plane of projection, which in this case is the angle the horizon makes with a line drawn from the point of projection to that point.

Hence also in horizontal cases, the durations of projections in different directions with the same impetus, are as the sines of the angles of elevation. But in ascents or descents their durations are as the sines of the angles which the lines of direction make with the inclined plane. Thus, suppose the impetus of any projection were 4,500 feet; then 16 feet 1 inch : 1″ : : 4,500 feet : 275″ the square of the time a body will take to fall perpendicularly through 4,500 feet, the square root of which is 16″ nearly, and that doubled gives 32″ the duration of the projection made perpendicularly upwards. Then to find the duration of a horizontal projection at any elevation, as 20°; say R : S. angle 20° : : 32″ : duration of a projection at that elevation with the impetus 4,500. Or if with the same impetus a body at the direction of 35° was projected on a plane inclined to the horizon 17°, say as sine 73° : sine 18° : : 32″ : duration required.

The tables in the next leaf, at one view, give all the necessary cases as well for shooting at objects on the plane of the horizon, with proportions for their solutions, as for shooting on ascents and descents. We shall in this place mention some of the more important maxims laid down by Mr. Robins, as of use in practice. 1. In any piece of artillery, the greater quantity of powder with which it is charged, the greater will be the velocity of the bullet. 2. If two pieces of the same bore, but of different lengths, are fired with the same charge of powder, the longer will impel the bullet with a greater celerity than the shorter. 3. The ranges of pieces at a given elevation, are no just measures of the velocity of the shot: for the same piece fired successively at an invariable elevation, with the powder, bullet, and every other circumstance as nearly the same as possible, will yet range to very different distances. 5. The greatest part of the uncertainty in the ranges of pieces, arises from the resistance of the air. 6. The resistance of the air acts upon projectiles by opposing their motion, and diminishing celerity; and it also diverts them from the regular track which they would otherwise follow. 7. If the same piece of cannon be successively fired at an invariable

elevation, but with various charges of powder, the greatest charge being the whole weight of the ball in powder, and the least not less than the fifth part of that weight; then, if the elevation be not less than eight or ten degrees, it will be found that some ranges with the least charge, will exceed some of those with the greatest. 8. If two pieces of cannon of the same bore, but of different lengths, are successively fired at the same elevation, with the same charge of powder, then it will frequently happen that some of the ranges with the shorter piece will exceed some of those with the longer. 9. Whatever operations are performed with artillery, the least charges of powder with which they can be effected, are always to be preferred. 10. No field-piece ought at any time to be loaded with more than one-sixth, or at most one-fifth of the weight of its bullet in powder, nor should the charge of any battering-piece exceed one-third of the weight of its bullet.

TABLE I. For Horizontal Projections. Fig. 10.

Cases.	Given.	Required.	Proportions.
1	A M, A m	t A H H v	2 A M : A m : : R : S. 2 angle t A H R : T. angle t A H : : $\frac{\text{A}\,m}{4}$: H v
2	A M, t A H	A m	R : S. 2 angle t A H : : 2 A M : A m.
3	A m, t A H	A M	S. 2 angle t A H : R : : $\frac{\text{A}\,m}{2}$: A M
4	A M, H v	A m	$\sqrt{\text{AN} \times \text{NM}} = \frac{\text{A}\,m}{4}$, or $\frac{1}{2}$ Log. A N $\times$ $\frac{1}{2}$ Log. N M $=$ Log. $\frac{1}{4}$ A m.
5	A m, H v	t A H A M	$\frac{\text{A}\,m}{4}$: H v : : R : T. angle t A H. A N : $\frac{\text{A}\,m}{4}$: : $\frac{\text{A}\,m}{4}$: N M, and A N $\times$ N M $=$ A M.
6	H v, t A H	A m	T. angle t A H : R : : H v : $\frac{\text{A}\,m}{4}$
7	t A H, A m and any other angle. any other amplitude.	any other amplitude belonging to that angle. any other angle belonging to that amplitude.	S. 2 angle t A H : S. 2 any other angle : : A m : amplitude required. A m : any other amplitude : : S. 2 angle t A H : S. 2 angle required.
8	t A H, H v. any other angle. any other altitude.	any other altitude. any other angle.	V. S. 2 angle t A H : V. S. 2 any other angle : : H v : altitude required. H v : any other altitude : : V. S. 2. angle t A H : V. S. 2 angle required.

TABLE II. For Projections on Ascents and Descents. Fig. 8, 9.

Cases.	Given.	Required.	Proportions.
1	A M, A *m*, B *m*, A B,	T A H, *t* A H.	A *m* : B *m* : : R : T. angle B A *m*, half of which added to 45°, gives angle G A *z*. A M : A B : : A *c* : A C $=$ C G. T. angle G A *z* : R : : G *z* : A *z*, and A *z* — A *f* $=$ *f z* $=$ P G. C G : P G : : R : V. S. of S G, half of which added to, or taken from G A *z*, gives the higher or lower direction required.
2	T A H, *t* A H, A F	A M	Log. of A M $=$ Log. of A F $\times$ 2 Log. S. angle M A F — Log. S. angle *s* A F — Log. S. angle M A *s*.
3	T A H, *t* A H, A M	A F	Log. of A F $=$ Log. A M $+$ Log. S. angle *s* A F $+$ Log. S. angle M A *s* — 2 Log. S. angle M A F.
4	B A *m*, *t* A H, A B, and any other angle *t* A H	A *b* the amplitude for that other angle.	Fig. 8. Log. A *f* $=$ Log. A F $+$ Log. S. angle *p* A *f* $+$ Log. S. angle *p* A M — Log. S. angle *s* A F — Log. S. angle M A *s*.
5	A M, D A H	A *g*	Fig. 5, 6. T. angle G A *z* : Sec. angle *g* A *z* : : G *z* : A *g*.

GUNPOWDER, a composition of nitre, sulphur, and charcoal, mixed together, and usually granulated. This easily takes fire, and when fired it rarefies or expands with great vehemence, by means of its elastic force. It is to this powder that we owe all the effect and action of guns, and ordnance of all sorts, so that fortification, with the modern military art, &c. in a great measure depends upon it.

The invention of gunpowder is ascribed by Polydore Virgil to a chemist, who having accidentally put some of his composition in a mortar, and covered it with a stone, it happened to take fire, and blew up the stone. Thevet says, that the person here spoken of was a monk of Fribourg, named Constantine Anelzen; but Belleforet, and other authors, with more probability, hold it to be Bartholdus Schwartz, or the black, who discovered it, as some say, about the year 1320; and the first use of it is ascribed to the Venetians in the year 1380, during the war with the Genoese. But there are earlier accounts of its use, after the accident of Schwartz, as well as before it; for Peter Mexia, in his "Various Readings," mentions that the Moors being besieged, in 1343, by Alphonsus the Eleventh, King of Castile, discharged a kind of iron mortars upon them, which made a noise like thunder: and this is seconded by what is related by Don Pedro, Bishop of Leon, in his Chronicle of King Alphonsus, who reduced Toledo, *viz.* that in a sea combat between the King of Tunis, and the moorish King of Seville, about that time, those of Tunis had certain iron tubs or barrels, with which they threw thunderbolts of fire.

Du Cange adds, that there is mention made of gunpowder in the registers of the chambers of accounts in France, as early as the year 1338. But it appears that Roger Bacon knew of gunpowder near one hundred years before Schwartz was born; and M. Dutens carries the antiquity of gunpowder still much higher, and refers to

the writings of the ancients themselves for the proof of it. It appears too, from many authors and many circumstances, that this composition has been known to the Chinese and Indians for thousands of years.

For some time after the invention of artillery, gunpowder was of a much weaker composition than that now in use, or that described by Marcus Græcus, which was chiefly owing to the weakness of their first pieces. Of twenty-three different compositions, used at different times, and mentioned by Tartaglia in his " Ques. and Inv. lib. 3, ques. 5;" the first, which was the oldest, contained equal parts of the three ingredients. But when guns of modern structure were introduced, gunpowder of the same composition as the present came into use. In the time of Tartaglia the cannon powder was made of four parts of nitre, one of sulphur, and one of charcoal; and the musket-powder of forty-eight parts of nitre, seven parts of sulphur, and eight parts of charcoal; or of eighteen parts of nitre, two parts of sulphur, and three parts of charcoal. But the modern composition is six parts of nitre, to one of each of the other two ingredients: though Mr. Napier says, he finds the strength commonly to be greatest when the proportions are, nitre three pounds, charcoal about nine ounces, and sulphur about three ounces. See his paper on gunpowder in the Transactions of the Royal Irish Academy, vol. ii. The cannon-powder was in meal, and the musket-powder grained; and it is certain, that the graining of powder, which is a very considerable advantage, is a modern improvement.

To make gunpowder duly, regard is to be had to the purity or goodness of the ingredients, as well as the proportions of them, for the strength of the powder depends much on that circumstance, and also on the due working or mixing of them together. See NITRE.

These three ingredients in their purest state being procured, long experience has shown that they are then to be mixed together in the proportion before-mentioned, to have the best effect, *viz.* three quarters of the composition to be nitre, and the other quarter made up of equal parts of the other two ingredients, or, which is the same thing, six parts nitre, one part sulphur, and one part charcoal.

But it is not the due proportion of the materials only, which is necessary to the making of good powder, another circumstance, not less essential, is the mixing them well together; if this be not effectually done, some parts of the composition will have too much nitre in them, and others too little; and in either case there will be a defect of strength in the powder.

After the materials have been reduced to fine dust, they are mixed together, and moistened with water, or vinegar, or urine, or spirit of wine, &c. and then beaten together for twenty-four hours, either by hand or by mills, and afterwards pressed into a hard, firm, solid cake. When dry, it is grained or corned, which is done by breaking the cake of powder into small pieces, and so running it through a sieve; by which means the grains may have any size given them, according to the nature of the sieve employed, either finer or coarser; and thus also the dust is separated from the grains, and again mixed with other manufacturing powder, or worked up into cakes again.

Powder is smoothed or glazed, as it is called, for small arms, by the following operation: a hollow cylinder or cask is mounted on an axis, turned by a wheel; this cask is half filled with powder, and turned for six hours, and thus by the mutual friction of the grains of powder it is smoothed or glazed. The fine mealy part, thus separated or worn off from the rest, is again granulated.

The velocity of expansion of the flame of gunpowder, when fired in a piece of artillery, without either bullet or other body before it, is prodigiously great, *viz.* seven thousand feet per second, or upwards, as appears from the experiments of Mr. Robins. But M. Bernoulli and M. Euler suspect it is still much greater; and Dr. Hutton supposes it may not be less, at the moment of explosion, than four times as much.

It is this prodigious celerity of expansion of the flame of gunpowder which is its peculiar excellence, and the circumstance in which it so eminently surpasses all other inventions, either ancient or modern; for as to the momentum of these projectiles only, many of the warlike machines of the ancients produced this in a degree far surpassing that of our heaviest cannon shot or shells; but the great celerity given to these bodies, cannot be in the least approached by any other means but the flame of powder.

To prove gunpowder. There are several ways of doing this. 1. By sight; thus if it be too black, it is a sign that it is moist, or

else that it has too much charcoal in it; so also if rubbed upon white paper it blackens it more than good powder does; but if it be of a kind of azure colour, somewhat inclining to red, it is a sign of good powder. 2. By touching; for if in crushing it with the fingers' ends, the grains break easily and turn into dust, without feeling hard, it has too much coal in it; or if, in pressing it under the fingers upon a smooth hard board, some grains feel harder than the rest, it is a sign the sulphur is not well mixed with the nitre. Also by thrusting the hand into the parcel of powder, and grasping it, as if to take out a handful, you will feel if it is dry and equal grained, by its evading the grasp and running mostly out of the hand. 3. By burning; and here the method most commonly followed for this purpose with us, says Mr. Robins, is to fire a small heap of it on a clean board, and to attend nicely to the flame and smoke it produces, and to the marks it leaves behind on the board; but besides this uncertain method, there are other contrivances made use of, such as powder-triers, acting by a spring, commonly sold at the shops, and others again that move a great weight, throwing it upwards, which is a very bad sort of eprouvette.

The best eprouvette consists in a small cannon, the bore of which is about one inch in diameter, and is usually charged with two ounces of powder, and with powder only, as a ball is not necessary, and the strength of the powder is accurately shown by the arc of the gun's recoil. The whole machine is so simple, easy, and expeditious that, as Dr. Hutton observes, the weighing of the powder is the chief part of the trouble, and so accurate and uniform, that the successive repetition, or firings, with the same quantity of the same sort of powder, hardly even yield a difference in the recoil of the one hundredth part of itself.

To recover damaged powder. The method of the powder merchants is this: they put part of the powder on a sail-cloth, to which they add an equal weight of what is really good, then with a shovel they mingle it well together, dry it in the sun, and barrel it up, keeping it in a dry and proper place.

Others again, if it be very bad, restore it by moistening it with vinegar, water, urine, or brandy; then they beat it fine, sift it, and to every pound of powder add an ounce, or an ounce and a half, or two ounces (according as it is decayed) of melted nitre, and afterwards these ingredients are to be moistened and well mixed, so that nothing may be discerned in the composition, which may be known by cutting the mass, and then they granulate it as useful. In case the powder be quite spoiled, the only way is to extract the salt-petre with water, in the usual way, by boiling, filtrating, evaporating, and crystallizing, and then with fresh sulphur and charcoal to make it up afresh.

On the subject of gunpowder, see also Euler on Robins's Gunnery, Antoni Examen de la Poudre, Baume's Chemistry, and Thompson's Experiments in the Philos. Trans. for 1781.

Soon after the discovery of the oxygenated-muriatic acid, and its combination with potash, it was found that this oxymuriate produced a much more violent detonation with combustible bodies, than is afforded by nitre. It has been estimated to possess more than double the force; but on account of this extraordinary power in gunpowder made with the new salt, and some fatal accidents by its exploding in consequence of friction or percussion to which it is liable, as well during the manufacture as afterwards, this modern compound has not been brought into use in military operations, but is likely to continue among the articles of scientific curiosity.

Gunpowder and Combustibles. No person shall make gunpowder but in the regular manufactories established at the time of making the statute 12 George III. c. 61, or licensed by the sessions, pursuant to certain provisions, under forfeiture of the gunpowder, and two shillings per pound; nor are pestle mills to be used under a similar penalty.

Only forty pounds of powder is to be made at one time under one pair of stones, except Battle-powder, made at Battle and elsewhere in Sussex.

Not more than forty hundred weight to be dried at one time in one stove; and the quantity only required for immediate use to be kept in or near the place of making, except in brick or stone magazines, fifty yards at least from the mill.

Not more than twenty-five barrels to be carried in any land carriage, nor more than two hundred barrels by water, unless going by sea or coastwise, each barrel not to contain more than one hundred pounds.

No dealer to keep more than two hundred pounds of powder, nor any person not a dealer, more than fifty pound in the

cities of London and Westminster, or within three miles thereof, or within any other city, borough, or market-town, or one mile thereof, or within two miles of the king's palaces or magazines, or half a mile of any parish church, on pain of forfeiture, and two shillings per pound, except in licensed mills, or to the amount of three hundred pounds for the use of collieries, within two hundred yards of them.

GUNTER (Edmund), an English mathematician of the seventeenth century, was descended from an ancient and respectable family in Brecknockshire, South Wales, and was born in the county of Herefordshire in the year 1580. He received his classical education on the royal foundation at Westminster School, whence he was elected at about eighteen years of age to Christ Church College, in Oxford. He was admitted to the degree of B.A. in 1603, and to that of M.A. in 1606; after which he entered into orders, and proceeded batchelor of divinity in the year 1615. His genius had early led him to the pursuit of mathematical studies; and at the time when he took his degree of M. A. he had merited the title of an inventor by his new projection of the sector, of which he then wrote a description in Latin, and permitted his friends to transcribe it, though the English account of his invention was not published till several years afterwards. In the year 1618 he had invented a small portable quadrant, for the more easy finding the hour and azimuth, and more useful astronomical purposes. The reputation which he had now acquired in the mathematical world occasioned his introduction to the acquaintance of some of the most able mathematicians of his time, by whose recommendation and interest he was elected professor of astronomy at Gresham College, London, in the year 1619. In this situation he soon distinguished himself by his lectures and his writings, which contributed greatly to the improvement of science, and reflected credit to the choice that had been made of him to that professorship. His first publication after his election appeared in 1620, and was entitled, "Canon Triangulorum, sive Tabulæ Sinuum artificialium ad radium 10.0000000, et ad Scrupula prima Quadrantis," 8vo. This treatise was accompanied with the first 1,000 of Brigg's logarithms of common numbers. In the second edition of it, which was published in English in 1624, under the title of "Canon Triangulorum, or Table of artificial Signs and Tangents to a radius of 10.0000000 Parts to each Minute of the Quadrant," 4to., the logarithms were continued from 1,000 to 10,000, and rule was given at the end for augmenting them to 100,000. These tables were the first of the kind which had been given to the world, and, if the author had published nothing else, would have preserved his memory to the latest posterity, by the admirable aid which they afforded to students in astronomy; for they greatly facilitated the practical parts of that science, by furnishing a method of solving spherical triangles without the aid of secants or versed sines; the same thing being effected by addition and subtraction only, which in the use of the former tables of right sines and tangents required multiplication and division. Due praise was bestowed upon him by many of the most eminent mathematicians among his contemporaries for the service which he rendered to science by this most excellent work; and his right to the improvement of logarithms, by their application to spherical triangles, was satisfactorily established by Mr. Edmund Wingate, Mr. Robert Burton, and Mr. Henry Bond, sen.

In the year 1622 Mr. Gunter made his important discovery, that the *variation* of the magnetic needle *varies*. To this discovery he was led in the course of lectures he made on the variation at Deptford, by which he found that the declination of the needle had changed almost five degrees in the space of forty-two years. The truth of this discovery was afterwards confirmed and established by Mr. Gellibrand, his successor at Gresham College. Soon after this he invented his famous "rule of proportion," which is an easy and excellent method of combining arithmetic and geometry, adapted to the understanding of persons of the most ordinary capacities. It consists in applying the logarithms of numbers and of sines and tangents to straight lines drawn on a scale or rule, by which, proportions in common numbers and trigonometry, may be resolved by the mere application of a pair of compasses; a method founded on this property, that the logarithms of the terms of equal ratios are equidifferent. This was called Gunter's proportion and Gunter's line; and the instrument in the form of a two foot scale is now in common use for navigation and other purposes, and is commonly called the Gunter. In the year 1624, this invention was carried into France by Mr. Wingate, who not only communicated it to most of the principal mathematicians

then at Paris, but also, at their request, published an account of it in the French language. Mr. Gunter likewise greatly improved the sector, and other instruments for the same uses, the description of all which he published in 1624, in a treatise entitled "The Cross Staff, in three Books," &c. 4to. In the same year he published, by King James's order, a small tract, entitled, "The Description and Use of his Majestie's Dials in Whitehall Garden," 4to. Mr. Gunter had been employed by the direction of King Charles in drawing the lines on these dials, and at his desire wrote this description, to which we refer those readers who wish to see a particular account of the construction and uses of those dials, which are no longer in existence. Our author was the first who used the word co-sine for the sine of the complement of an arc. He also introduced the use of arithmetical complements into the logarithmical arithmetic; and it has been said, that he first started the idea of the logarithmic curve, which was so called because the segments of its axis are the logarithms of the corresponding ordinates. To him likewise the mathematical world is indebted for many other inventions and improvements, most of which were the subjects of his lectures at Gresham College, and afterwards disposed into treatises, which were printed in his works. From the genius and abilities which he had displayed in his works already noticed, the highest expectations were formed of his future services in the cause of useful science; but they were unhappily disappointed by his death, in 1626, when he was only in the forty-fifth year of his age. His name, however, will be transmitted with honour to posterity, as that of the parent of instrumental arithmetic. His works have been collected, and various editions of them have been published. The fifth is by William Leybourn, in 1673, 4to., containing the description and use of the sector, cross-staff, bow, quadrant, and other instruments; with several pieces added by Samuel Foster, Henry Bond, and William Leybourn.

GUNTER'S *chain*, the chain in common use for measuring land, according to true or statute measure; so called from Mr. Gunter, its reputed inventor. The length of the chain is 66 feet, or 22 yards, or 4 poles, of $5\frac{1}{2}$ yards each; and it is divided into 100 links, of 7.92 inches each. This chain is the most convenient of any thing for measuring land, because the contents thence computed are so easily turned into acres. The reason of which is, that an acre of land is just equal to 10 square chains, or 10 chains in length and one in breadth, or equal to 100,000 square links. Hence, the dimensions being taken in chains, and multiplied together, it gives the content in square chains, which therefore being divided by 10, or a figure cut off for decimals, brings the content to acres; after which the decimals are reduced to roods and perches, by multiplying by 4 and 40. But the better way is to set the dimensions down in links, as integers, considering each chain as 100 links; then, having multiplied the dimensions together, producing square links, divide these by 100,000, that is, cut off five places for decimals, the rest are acres, and the decimals are reduced to roods and perches as before. Suppose a field to be measured be 887 links in length, and 750 in breadth, to find its area we say

$$\begin{array}{r} 887 \\ 750 \\ \hline 44350 \\ 6209 \\ \hline 6.65250 \\ 4 \\ \hline 2.61000 \\ 40 \\ \hline 24.4 \end{array}$$

The contents are 6 *A.* 2 *R.* 24 *P.*

GUNTER'S *line*, a logarithmic line, usually graduated upon scales, sectors, &c. It is also called the line of lines, and line of numbers; being only the logarithms graduated upon a ruler, which therefore serves to solve problems instrumentally in the same manner as logarithms do arithmetically. It is usually divided into an hundred parts, every tenth thereof is numbered, beginning with 1, and ending with 10; so that if the first great division, marked 1, stand for one tenth of any integer, the next division, marked 2, will stand for two-tenths; 3, three-tenths, and so on; and the intermediate divisions will, in like manner, represent 100th parts of the same integer. If each of the great divisions represent 10 integers, then will the lesser divisions stand for integers; and if the great divisions be supposed each 100, the subdivisions will be each 10.

GUNTER'S *line, use of.* 1. "To find the product of two numbers." From 1 extend the compasses to the multiplier; and the same extent, applied the same way from the multiplicand, will reach to the product. Thus, if the product of 4 and 8 be required, extend the compasses from 1 to 4, and that

extent laid from 8 the same way, will reach to 32, their product. 2. "To divide one number by another." The extent from the divisor to unity will reach from the dividend to the quotient: thus to divide 36 by 4, extend the compasses from 4 to 1, and the same extent will reach from 36 to 9, the quotient sought. 3. "To three given numbers, to find a fourth proportional." Suppose the numbers 6, 8, 9; extend the compasses from 6 to 8, and this extent, laid from 9 the same way, will reach to 12, the fourth proportional required. 4. "To find a mean proportional between any two given numbers." Suppose 8 and 32: extend the compasses from 8 in the left-hand part of the line to 32 in the right; then bisecting this distance, its half will reach from 8 forward, or from 32 backward, to 16, the mean proportional sought. 5. "To extract the square root of any number." Suppose 25: bisect the distance between one on the scale and the point representing 25; then the half of this distance, set off from 1, will give the point representing the root 5. In the same manner the cube root, or that of any higher power, may be found by dividing the distance on the line, between 1 and the given number, into as many equal parts as the index of the power expresses; then one of those parts, set from 1, will find the point representing the root required.

GUNTER'S *quadrant*, one made of wood, brass, &c. containing a kind of stereographic projection of the sphere, on the plane of the equinoctial; the eye being supposed placed in one of the poles. Besides the use of this quadrant in finding heights and distances, it serves also to find the hour of the day, the sun's azimuth, and other problems of the globe.

GUNTER'S *scale*, usually called by seamen the Gunter, is a large plain scale, having various lines upon it, of great use in working the cases or questions in navigation. This scale is usually two feet long, and about an inch and a half broad, with various lines upon it, both natural and logarithmic, relating to trigonometry, navigation, &c. On the one side are the natural lines, and on the other the artificial or logarithmic ones. The former side is first divided into inches and tenths, and numbered from one to twenty-four inches, running the whole length near one edge. One half the length of this side consists of two plain diagonal scales, for taking off dimensions to three places of figures. On the other half or foot of this side, are contained various lines relating to trigonometry, in the natural numbers, and marked thus, *viz.*

Rumb, the rumbs or points of the compass;

Chord, the line of chords;
Sine, the line of sines;
Tang. the tangents;
S. T. the semi-tangents; and at the other end of this half are,

Leag. leagues, or equal parts;
Rumb, another line of rumbs;
M. L. miles of longitude;
Chor. another line of chords.

Also in the middle of this foot are L, and P, two other lines of equal parts: and all these lines on this side of the scale serve for drawing or laying down the figures to the cases in trigonometry and navigation. On the other side of the scale, are the following artificial or logarithmic lines, which serve for working or resolving those cases; *viz.*

S. R. the sine rumbs;
T. R. the tangent rumbs;
Numb. line of numbers;
Sine, sines;
V. S. the versed sines;
Tang. the tangents;
Meri. Meridional parts;
E. P. Equal parts.

GUN-WALE, or *Gunnel*, is the uppermost wale of a ship, or that piece of timber which reaches on either side from the quarter-deck to the forecastle, being the uppermost bend which finishes the upper works of the hull, in that part in which are put the stanchions which support the waste-trees.

GUSSET, in heraldry, is formed by a line drawn from the dexter or sinister chief points, and falling down perpendicularly to the extreme base.

GUST, in sea-language, a sudden and violent squall of wind, bursting from the hills upon the sea, so as to endanger the shipping near the shore. These are peculiar to some coasts, as those of South Barbary and Guinea.

GUSTAVIA, in botany, so named in memory of Gustavus III. King of Sweden: a genus of the Monadelphia Polyandria class and order. Natural order of Myrti, Jussieu. Essential character: calyx none; petals several; berry many-celled; seeds appendicled. There is but one species, *viz.* G. augusta, which is a tree from twenty to thirty feet in height. It is a native of Surinam and Cayenne.

GUTTA *serena*, a disease in which the pa-

tient, without any apparent fault in the eye, is entirely deprived of sight.

GUTTÆ, in architecture, are ornaments in the form of little cones, used in the plafond of the Doric corniche, or on the architrave underneath the triglyphs, representing a sort of drops or bells. They are usually six in number.

GUTTERS, in architecture, a kind of canals in the roofs of houses, serving to receive and carry off the rain.

GUTTURAL, a term applied to letters or sounds pronounced or formed as it were in the throat, *viz.* אהחע, which, for memory's sake, are termed *ahachah*.

GUTTY, in heraldry, a term used when any thing is charged or sprinkled with drops. In blazoning, the colour of the drops is to be named, as gutty of sable, of gules, &c.

GUY, in a ship, is any rope used for keeping off things from bearing or falling against the ship's sides when they are hoisting in.

That rope, which at one end is made fast to the fore-mast, and seized to a single block at the pendant of the garnet, is called the guy of the garnet.

GYBING, the art of shifting any boom-sail from one side of the vessel to another. By a boom-sail is meant any sail, the bottom of which is extended by a boom, (see BOOM) the fore-end of which is hooked to its respective mast, so as to swing occasionally on either side of the vessel, describing an arch of which the mast is the centre. As the wind changes, it becomes necessary to change the position of the boom, together with its sail, which is accordingly shifted to the other side of the vessel, as a door turns upon its hinges.

GYMNANTHES, in botany, a genus of the Monoecia Monadelphia class and order. Essential character: male ament naked; perianth and corolla none; stamina pedicels three-parted or three-forked, anther bearing; female ament or germ pedicelled; corolla none; style trifid; capsule tricoccous, three-celled. There are two species, natives of the West Indies.

GYMNASTICS. This word, derived from the Greek, comprehends all those athletic exercises by which the ancients rendered the body pliant and healthy, and enabled the muscles to do their offices with treble effect. The variety of methods contrived for this purpose was very numerous, and the ardour with which they were pursued at every opportunity, contributed to banish all dread of personal danger, and prepared the youth of each nation for the military life.

Persons were appointed to teach the various sports, and the gymnasium was a public receptacle for their performance; the exercises amounted to nearly sixty descriptions, and the parties concerned in them originally appeared in drawers, but afterwards totally naked, in order to give full scope to their limbs. The gymnasium was under the superintendance of a master, styled gymnasiarch, who had two assistants, the xystarch and the gymnastis. The master was selected from the higher classes of the people, as his office was of considerable importance, and his deputies presided over the inferior persons employed in teaching; the former directing the wrestlers, and the latter the progress of the other exercises, that the youths might neither suffer through accident or too violent exertion.

It has been asserted that the whole system of education amongst the Greeks, was comprehended in two essential points, gymnastics and music; dancing, under several divisions, invariably accompanied their music in warlike, festive, and bacchanalian movements, to which they added, at proper times, tumbling, numerous modes of playing with the ball, leaping, foot-races, pitching the discus, throwing the javelin, wrestling, boxing, &c. Tumbling was entitled cubistics; the amusements of the ball they comprehended under the term spheristics; the exercises of leaping, foot-racing, the discus, the javelin, and wrestling, they included in the word palestrics.

The moralists and medical men of antiquity, highly approved of those sports which were calculated to bring health, strength, and grace in their train; but were energetic and vehement in their censures of the athletes, who wrestled and boxed with angry violence, and afterwards indulged in vicious excesses.

Leaping a considerable distance with ease, was one of the innocent and useful acquirements of the Grecian youth, which they soon attained, but which they appear to have despised, as incapable of difficulty; therefore, to render the art laborious, and increase their weight, they adopted the practice of bearing lead on their heads and shoulders, fastening it to their feet, and holding it in their hands. A youth, thus loaded, and almost pinioned to the earth by attraction, who sprung a greater distance than his competitors under the same circumstances, was

hailed with loud plaudits, proportioned to the surprise excited by his uncommon strength of muscles.

The pedestrian races admitted of more ardent endeavours than leaping; not a moment could be lost or granted for relaxation; the shouts of the teachers, and of the spectators, were incentives for exertion, and, divested of clothing, the efforts of the least successful were wonderful. Homer illustrates this part of the subject in his inimitable "Iliad."

"Rang'd in a line the ready racers stand;
Pelides points the barrier with his hand;
All start at once; Oileus led the race;
The next, Ulysses, measuring pace with pace;
Behind him, diligently close, he sped,
As closely following as the running thread
The spindle follows, and displays the charms
Of the fair spinster's breast, and moving arms:
Graceful in motion thus, his foe he plies,
And treads each footstep ere the dust can rise:
His glowing breath upon his shoulders plays;
The admiring Greeks loud acclamations raise;
To him they give their wishes, hearts, and eyes,
And send their souls before him as he flies."

Iliad, book xxiii. 885, 895.

Rapidity of motion might be useful to the ancients in many particulars, though less so than to the uncivilized nations generally termed savage; the inhabitants of the latter seem indeed compelled to acquire swiftness in running, as the pursuit of wild animals is absolutely necessary to maintain their existence; and some of the native chiefs of India and its dependencies retain persons to convey dispatches from station to station by pedestrian exertion.

Throwing the dart or spear, was of decided importance in ancient warfare, and the skill of their soldiers was probably very great. In this instance, however, it may be doubted, whether all the advantages of their gymnasiums enabled them to excel some of the tribes of Hottentots, exclusive of savages in a superior state of civilization; the debased people alluded to, possess wonderful ability in throwing and arresting the progress of spears; the writer of the present article had an opportunity of knowing, from a witness of the scene, that a Hottentot frequently caught a heavy pole hurled at him by a strong man, ere it had power to injure him.

Throwing the discus, now known by the name of the quoit, required equal strength and skill; the shape of the discus was nearly oval, about a foot in length, and three or four inches thick in the centre, whence it tapered on each side to the extremity, in the manner of a lens, and a hole was perforated in the middle. Statues of persons employed at this game exhibit them with the discus "rested on the four fingers, which were closed, with their ends pointing upward on the inside of it; the thumb was extended horizontally along the outside."

Salzmann says, the thrower obtained the necessary impulse by swinging the arm, and at the proper moment he gave the discus a rotatory motion, and sent it through the air to the mark. Kennet asserts, in describing the Roman Circensian shows, that they obtained their quinquertium, or the five exercises of running, wrestling, leaping, throwing, and boxing, from the Grecian games, and adds, that the discus or quoit of the former people, "was made of stone, iron, or copper, five or six fingers broad, and more than a foot long, inclining to an oval five; they sent this to a vast distance, by the help of a leathern thong tied round the person's hand that threw." The latter particular has been disputed, and the position is maintained by observing, that had a thong been used, it was unnecessary for the discobuli to rub their hands on the earth, to prevent the discus from slipping; besides, the strap would have interrupted the rotatory whirl thought indispensable for its steady course.

If we may depend upon Homer, the weight of the discus was an object of some importance:

"Then hurl'd the hero, thund'ring on the ground
A mass of iron, (an enormous round)
Whose weight and size the circling Greeks admire,
Rude from the furnace, and but shap'd by fire.
This mighty quoit Aëtion wont to rear,
And from his whirling arm dismiss in air:
The giant by Achilles slain, he stow'd
Among his spoils this memorable load.
For this he bids those nervous artists vie,
That teach the disc to sound along the sky."

Book xxiii. 973.

Galen classed the discus in the medicinal gymnastics, in hurling which he was declared the victor who sent it highest in the air, the greatest distance, and the nearest to the mark. Circular quoits, resembling a broad ring, and made of iron, are still used in England, but it is extremely doubtful whether the most experienced player could rival the inferior discobuli of ancient times.

Wrestling was the only exercise of those already mentioned, which could be said to be improper or dangerous. Tertullian reprobated it, and Galen suffered a dislocation of his shoulder when wrestling, which satisfactorily accounts for his enmity to the sport. It is rather singular that this method of trying muscular strength should have prevailed, when it is remembered that strains of the muscles and dislocation of the joints, and even fractured limbs and skulls, were consequences not improbable; in addition to these objections it must be allowed that no method more certain could be devised for the excitement of sudden anger and blows. To obviate the first of these disadvantages, the Grecian athletes anointed their bodies with oil, hoping by this means to render their joints more flexible, though some authors have supposed the practice originated from an intention to prevent their adversaries obtaining a firm grasp of the limbs, and others think it was done to check profuse and debilitating perspirations. The mode adopted to save the limbs from fractures was absurd indeed, they lived well and contrived every possible way to make themselves corpulent, that their flesh might act between their bones and the earth, as a medium or cushion, forgetting, that as their gravity increased, the bruises they received were proportionally more violent, and a fracture more difficult to reduce.

Besides the application of oil, and rubbing it on the surface of the skin till the friction produced a glow; it is said they added dust or sand, but for what purpose, unless to close the pores, cannot well be decided. Salzmann says, "after this preparation the exercise itself commenced. The combatants began with handling each other slightly, each pressing or pulling his antagonist backwards and forwards, till they grew warm, then butting him with his head, thrusting him from his ground, assailing him with all his force, wrenching his limbs, shaking him, twisting his neck so as to choke him, lifting him up in his arms, &c. This kind of wrestling was called ορθια παλη, because it was performed standing: and he was declared victor who threw his antagonist thrice. Another kind was performed on the ground. This was called ανακλινοπαλη. Every thing was practised in this, that was in wrestling erect, as far as the posture would allow. The combatants voluntarily lay down, and he whose strength was first exhausted lost the victory, which he acknowledged by words, or by holding up one of his fingers.

"With wrestling, the athletes afterwards united the savage practice of boxing, which was known before the Trojan war. Hence arose the two-fold contest called παγκρατιον, which was pursued to excess by the athletes, but could scarcely be considered as a part of medicinal gymnastics in the schools. No ancient physician recommends boxing in a medical view. The boxers likewise laid great stress on rendering their bodies corpulent, that they might be the better able to bear the blows of their antagonists." The same author adds, "The boxers fought erect, never hugging their antagonist, and throwing him down, but merely striking him: the wrestlers were not allowed to strike: the pancratiasts united the two, both wrestling and striking."

Kennet refers the Ludus Trojæ, celebrated by bands of boys, to the invention of Ascanius. The youths engaged in this exercise were selected from the most honourable families of Rome, were elegantly habited, and armed with weapons of a size proportioned to their age. The commander received the title of Princeps Juventutis, and was sometimes the son of a senator, and not unfrequently the heir to the empire. Augustus was extremely partial to their infantile imitations of the ardour of manhood; and Virgil, aware of his partiality, introduced a description of their celebrations in his Eneid. They wore chaplets of flowers on their heads, and their hair flowed loose from beneath it; their vests were purple; and twists of gold. disposed in circles, attached to the neck, spread down their breasts; quivers hung on their shoulders; they carried two spears; and were mounted on spirited horses. Virgil, in the passage alluded to, divides the youths into three troops, each consisting of twelve, under the command of a captain, amounting in the aggregate to thirty-nine

individuals. Thus equipped they walked their horses round the circus.

"When sage Epytides, to give the sign,
Crack'd his long whip, and made the course begin."

They then started forward at full speed, and afterwards formed into divisions, returning back.

"——— while from their fingers borne,
Their hostile darts aloft upon the wind
Fly shivering: then in circling numbers join'd,
The manag'd coursers with due measures bound,
And run the rapid ring, and trace the mazy round.
Files facing files, their bold companions dare,
And wheel and charge, and urge the sportive war.
Now flight they feign, and naked backs expose;
Now with turn'd spears drive headlong on the foes;
And now confederate grown, in peaceful ranks they close."

The chariot races do not strictly belong to this article, but they were so far connected with personal exercises in the Circus, that it would be almost unpardonable to pass them without notice. Strength and agility were entirely useless in the conduct of the chariot; courage and address in guiding the fiery steeds were all that was requisite in the driver. The charioteers were formed into companies in the Roman Circensian spectacles, and they excited great interest throughout Rome, the inhabitants of which were generally divided into parties, each attached to their favourite company. This, in common with their other sports, was derived from the Greeks. The different ancient divisions were distinguished by the colours of their habits, which were green, red, white, and blue; and they were termed the Prasina, the Russata, the Alba, and the Veneta.

The antiquity of the Pyrhica, or Saltatio Pyrhica, led ancient authors into many fanciful ideas, whence this warlike dance originated. Homer introduces it in its primitive state, in his description of the twelfth department of the shield of Achilles. "The skilful Vulcan then designed the figure and various motions of a dance, like that which Dædalus, of old, contrived in Gnossus for the fair Ariadne. There the young men and maidens danced hand in hand; the maids were dressed in linen garments, the men in rich and shining stuffs; the maids had flowery crowns on their heads, the men had swords of gold hanging from their sides in belts of silver. Here they seem to run in a ring with active feet as swiftly as a wheel runs round when tried by the hands of the potter. There they appeared to move in many figures, and sometimes to meet, sometimes to wind from each other. A multitude of spectators stood round delighted with the dance. In the middle, two nimble tumblers exercised themselves in feats of activity, while the song was carried on by the whole circle."

At the period when the dance was practised in the Roman amphitheatres, it had assumed a warlike appearance, the performers advancing and flying alternately as if engaged in battle. Claudian says,

"Their moving breasts in tuneful changes rise,
The shields salute their sides, or straight are shewn
In air high waving; deep the targets groan,
Struck with alternate swords which thence rebound,
And end the concert and the sacred sound."

Scaliger informs us, with some degree of vanity, that he had often danced the pyrhic in presence of the Emperor Maximilian, to the admiration and amazement of the inhabitants of Germany, and, as it appears, to that of the Emperor, who, he adds, exclaimed, "This boy either was born in a coat of mail, instead of a skin, or else has been rocked in one instead of a cradle."

Real or supposed improvements in the customs of the European nations, have now nearly abolished or altered almost all of the ancient gymnastic exercises; active feats and sudden turns of the body, or tumbling, are totally despised and confined to the most pitiful public exhibitions; playing with the ball is very little practised; leaping and foot races are limited to a few wagers; pitching the quoit seldom extends beyond the apprentice and the labourer; throwing the javelin is entirely discontinued; wrestling, long a favourite athletic exercise in

England, belongs almost exclusively to the wanton school-boy; boxing, (thanks to our morals) to the lowest wretches in society; the tournament, evidently derived from the Ludus Trojæ, is nearly forgotten; the chariot race is in the same state of disuse; and we have nothing which resembles the military pyrhic; and even the faint similarity of the games enumerated are supported by the caprice of a few individuals, who are often condemned for employing their time to so little purpose.

On the other hand, if we turn our attention to the rest of the world, we shall find that many of the gymnastic sports are in full use at this moment, without the inhabitants suspecting that nations very remote from them had similar some thousand years past. Two instances of this fact are so exactly in point, that we cannot refrain from giving them. Mr. Cordiner, who very lately presented the public with an excellent work, descriptive of the island of Ceylon, relates the particulars of a Cingalese play, in the following words:

"Gay and noisy amusements do not often interrupt the predominant repose of the genuine Ceylonese; but a sort of comical representation is sometimes attempted, to gratify a man of elevated rank, or to celebrate an occasion of extraordinary festivity. On the 28th of December, 1803, while Lord Viscount Valentia was visiting Governor North, at Columbo, a numerous company of the British inhabitants were favoured, after dinner, with the sight of an exhibition, called by the natives a Cyngalese play, although from the rude nature of the performance it can hardly be ranked among the productions of the dramatic art. The stage was the green lawn before his Excellency's villa at St. Sebastian, and the open theatre was lighted with lamps supported on posts, and flambeaus held in men's hands. The entertainment commenced with the feats of a set of active tumblers, whose naked bodies were painted all over with white crosses. They walked on their hands, and threw themselves round, over head and heels, three or four times successively, without a pause. Two boys embracing one another, with head opposed to feet, tumbled round like a wheel, but necessarily with a slower motion, as a momentary stop was required when each person touched the ground. The young performers, singly, twisted their bodies with a quickness and flexibility which it would be difficult to imitate in a less relaxing climate. Some of the movements produced sensations by no means agreeable, as they conveyed the idea of occasioning uneasiness to the actors. After this, six or seven professed dancers appeared on the stage. They were dressed like the gay damsels on the coast of Coromandel; but the greater part of them appeared not to be females, and an inferiority of gesticulation was visible in the style of their performance. Two men, raised upon stilts, walked in amongst them, exhibiting a most gigantic stature; pieces of bamboo were tied round their legs, reaching only a little above the knee, and elevating them three feet from the ground; they moved slowly, without much ease, and had nothing to support them but the equipoise of their own bodies:" a man then appeared, masked, armed with a sword and switch, and habited in the old Portuguese dress; two others, resembling Dutchmen, and masked, preceded, who skipped about and drove all before them in an imperative manner; groupes of horrible masks, set with teeth, one of which had the head and proboscis of an elephant, followed; the persons who bore them carried lighted torches in each hand, those they whirled rapidly round, alternately lighting and extinguishing them in the course of their revolutions; these personified devils, and sometimes laughed to excess, but said little; imitations of wild animals next appeared; "but the prettiest part of the entertainment was a circular dance, by twelve children about ten years of age; they danced opposite to one another, two and two, all courtesied at one time down to the ground, shook their whole bodies with their hands fixed in their sides, and kept time to the music with two little clattering sticks, one in each hand. Going swiftly round, being neatly dressed, of one size, and perfect in the performance, this youthful dance produced a very pleasing effect, and brought to remembrance the pictures of the fleeting hours."

Captain Cook relates, in the second volume of the account of his voyage to the Pacific Ocean and the Sandwich Islands, that the natives play at bowls with pieces of whetstone, in shape resembling a small cheese, rounded at the edges, highly polished, and weighing about a pound. "They also use, in the manner that we throw quoits, small, flat, rounded pieces of the writing-slate, of the diameter of the bowls, but scarcely a quarter of an inch thick, also well polished."

GYMNOTHORAX, the *muræna*, in na-

tural history, a genus of fishes of the order Apodes. Generic character: body eel-shaped, no pectoral fins; spiracle single, on each side the neck, small, oval, and uncovered. There are four species according to Gmelin, but Shaw enumerates eleven. The G. romana abounds on the Mediterranean coasts, and attains nearly to the size of the common eel. It is principally found in salt water, but will live equally well in fresh. It is highly voracious, and preys upon a vast variety of smaller animals. It was regarded by the Romans as one of the first of delicacies, and the rich and noble frequently kept these fishes in large reservoirs, in which they were at once fed for the table, and afforded entertainment by the tameness and familiarity to which they were easily disciplined. V. Pollio once ordered a slave, who had offended him by neglect, in the presence of the Emperor, to be cut in pieces and given for food to his murænas, at which the Emperor Augustus was so much disgusted, that he instantly ordered the ponds of this nobleman to be filled up, and his slave to be liberated, and was induced to spare the life of this tyrant, only from a regard to an acquaintance of considerable duration.

GYMNOTUS, the *gymnote*, in natural history, a genus of fishes of the order Apodes. Generic character: the head with lateral opercula; two tentacula on the upper lip; eyes covered by the common skin; gill-membrane five-rayed; body compressed, generally without a dorsal fin, but carinated by a fin beneath. There are nine species, of which we shall notice G. electricus or the electrical gymnote. This is generally of the length of three or four feet, is of an unpleasant appearance, much like a large eel, but thicker in proportion to the length, and always of the colour of a blackish brown. It has, occasionally, been seen of the length of ten feet. It is found in the hot climates of Africa and America, particularly in the rivers of Surinam and Senegal. Towards the close of the 17th century, a memoir was presented by M. Richer to the French Academy, announcing his discovery of a very peculiar quality of this fish, by which it communicated to the person touching it a very sudden and violent shock. This statement, however, was considered as fabulous for a considerable time, and it was not till about the middle of the last century that all scepticism on this subject, even among learned and scientific men, completely vanished, and this very peculiar property was universally allowed to attach to the fish in question. Dr. Garden, of Charlestown, in South Carolina, after giving an elaborate description of the form and structure of this animal, adds, that it has the power of giving an electrical shock to any person, or to any number of persons who join hands together, the extreme person on each side touching the fish. There were five of these fishes under his immediate inspection at the above town, all which possessed this property in a high degree, and they could communicate the shock to any number of individuals, either by the immediate touch of the fish by one of them, or through the medium of a metalline rod; but when they were first caught this power was more fully possessed by them than sometime afterwards. He observed that, in his own case, the shock was never experienced, when the fish was laid hold of by him with one hand only; when it was held by both hands at a considerable distance apart, he never failed to receive a sensible and smart one. Indeed if it be held by one hand, and the other hand be immersed in the water immediately over the body of the fish, the same effect will follow as if the fish were held by both hands, and so it will be with respect to any number of persons joining in a circle, one hand of the person at one extremity holding the fish, and the person at the other extremity, placing his hand in the water over the gymnote. This shock is considered as completely electrical, all the circumstances of it resembling those of the electricity of the atmosphere. It is passed by the same conductors, and interrupted by the same electrics. These fishes are caught in Surinam river, considerably above the reach of the sea-water. They subsist on fishes, worms, or any animal food, which is small enough for them to swallow; and when any fish is thrown at them, they will immediately communicate to it a shock, by which it is stupified. If the fish be large, several shocks are requisite, and are applied for this purpose, and many are thus destroyed by the gymnote which it is unable to swallow, and after repeated attempts finds itself obliged to abandon. The shock inflicted by these creatures on others intended by them for prey, is by no means always, nor perhaps generally fatal, and many have been speedily recovered after being removed into another vessel from that in which they received the

PISCES. *Plate IV.*

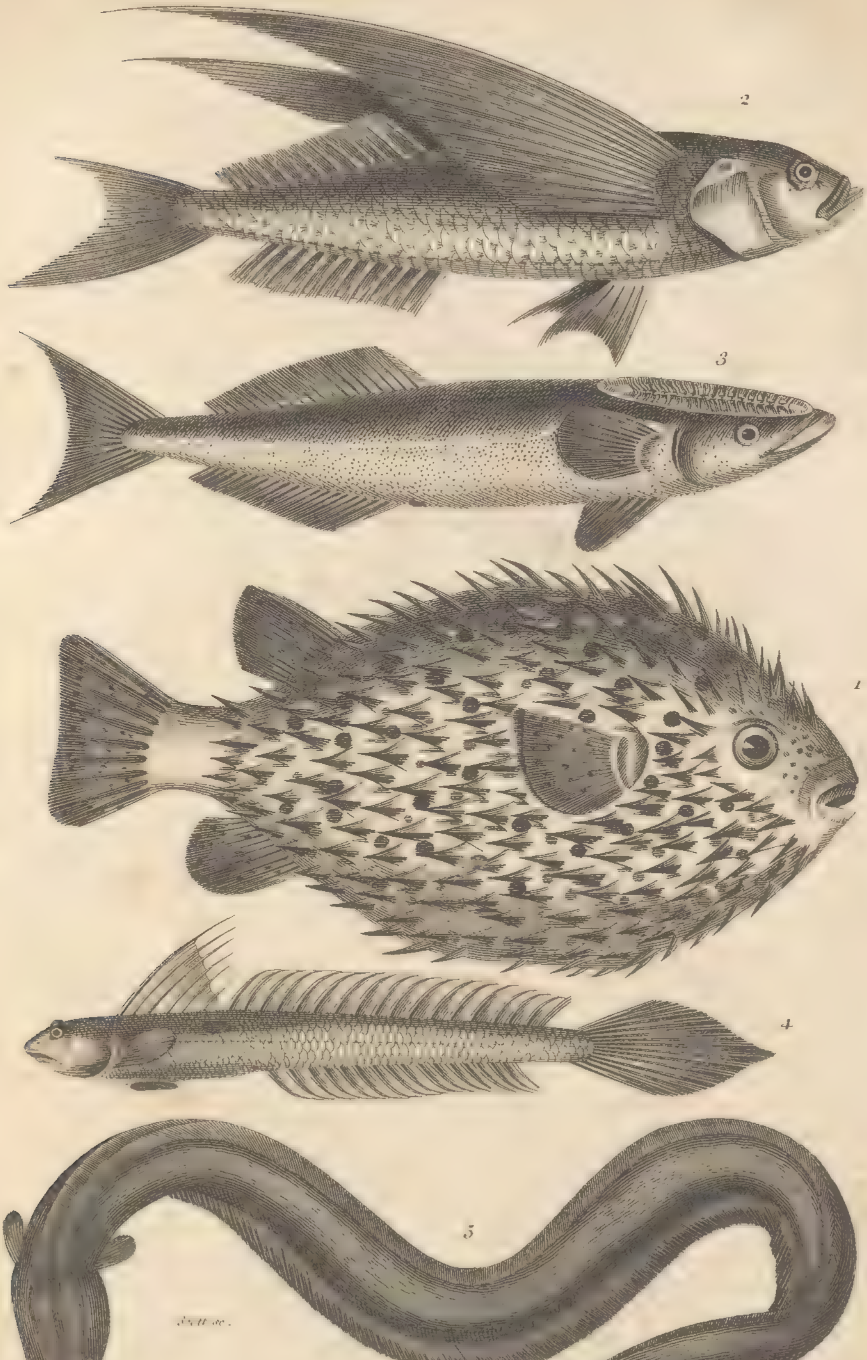


Fig.1. Diodon *hystrix: Porcupine diodon_ Fig.2.* Exocoetus *exiliens: Oceanic flying fish Fig.3.* Echineis *remora: Mediterranean remora _ Fig.4.* Gobius *lanceolatus: Lance-tailed goby_ Fig.5.* Gymnotus *electricus: Electrical gymnote.*

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shock, and in which they were rendered motionless, and to all appearance dead by it. It appears that the electrical fish has no teeth, and the most minute examination of the fishes contained in their stomachs could discover no marks of laceration, even in the slightest degree. Gymnotes of three feet in length are incapable of swallowing any fish larger than three inches and a half. It appears that the strength of their peculiar talent is in proportion to their magnitude, and it is stated that there are some in Surinam river, whose length is twenty feet, and whose shock is followed by immediate death to any human being, who is so unfortunate as to be exposed to it. It is observed, that even after the electrical fish is dead, it retains, for a considerable time, more or less of this singular property. It is a fish greatly and justly dreaded by the inhabitants of those countries, the rivers of which it frequents; it is however, notwithstanding this circumstance, used by them for food, and even by some, considered as a capital delicacy. For a representation of the gymnotus electricus, see Pisces, Plate IV. fig. 5.

GYNANDRIA, in botany, the name of the twentieth class in the Linnæan system. It consists of plants with hermaphrodite flowers, in which the stamina are placed upon the style, or upon a pillar-shaped receptacle resembling a style, which rises in the middle of the flower, and bears both the stamina and pointal. There are seven orders in this class, each of which is founded on the number of the stamina in the plants which compose it. See BOTANY.

GYNOPOGON, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Apocineæ, Jussieu. Essential character: calyx half five-cleft, inferior, permanent; corolla five-parted, tube ventricose below the tip, throat contracted; stigma globular, two-lobed; berry pedicelled, sub-globular; seed cartilaginous, sub-bilocular. There are three species, natives of the islands in the South Seas.

GYPSIES. There are several statutes against them, by which they are treated as rogues and vagabonds.

GYPSOPHILA, in botany, a genus of the Decandria Digynia class and order. Natural order of Caryophyllei. Essential character: calyx one-leafed, bell-shaped, angular; petals five, ovate, sessile; capsule globular, one-celled. There are twelve species.

GYPSUM, a substance well known to the ancients, and one that is very abundant in nature, and is now denominated, according to the new chemical arrangement, the sulphate of lime. It forms immense strata, composing entire mountains; it is found in almost every soil, either in greater or less quantities; it is contained in the waters of the ocean, and in almost all river and spring water. In these its presence is the cause of the quality termed hardness, which may be known by the water being incapable of forming a solution of soap, the sulphuric acid seizing on the alkali of the soap, and the oil forming a compound with the lime. Sulphate of lime is insipid, white, and soft to the touch. Water will not hold a 500th part of it in solution. Exposed to heat it appears to effervesce, which phenomenon is caused by the expulsion of water. It becomes opaque, and falls into powder. This powder, when its water has been driven off by the application of a red heat, absorbs water rapidly, so that if it be formed into a paste with water, it dries in a few minutes. In this state it is called plaster of Paris, and is employed for forming casts, and for a variety of purposes in the art of statuary.

GYRINUS, in natural history, *water-flea*, a genus of insects of the order Coleoptera. Antennæ cylindrical; jaws horney, one-toothed, sharp-pointed; eyes four, two above and two beneath; thorax and shells margined, the latter shorter than the body; legs formed for swimming. The insects of this genus are to be found on the surface of waters, on which they run, and describe circles with a great degree of swiftness; when attempted to be taken, they plunge to the bottom, drawing after them a bubble very similar to a globule of quicksilver. Eleven species of the gyrinus have been described, of which one only is found in Europe, *viz.* G. natator, a small insect, not more than a quarter of an inch long, of a blackish colour, but with so bright a surface as to shine like a mirror in the sun. The larva is of a very singular aspect, having a lengthened body, furnished with many lateral appendages down the body, exclusively of six legs. Dr. Shaw says, its motions are extremely agile, swimming in a kind of serpentine manner, and preying on the smaller and weaker water-insects, minute worms, &c. It is a highly curious object for the microscope. When its change arrives, it forms for itself a small oval cell or case on a

leaf of some water plant, and after casting its skin it becomes a chrysalis. These animals, in large numbers, give out a disagreeable smell, and like other water beetles, they fly only by night. Their eggs are white, and are laid on the stems of water-plants, where they are hatched in the course of a week, and instantly begin to swim about very swiftly in quest of prey.

H.

H, Or *h*, the eighth letter, and sixth consonant in our alphabet; though some grammarians will have it to be only an aspiration or breathing.

It is pronounced by a strong expiration of the breath between the lips, closing, as it were, by a gentle motion of the lower jaw to the upper, and the tongue nearly approaching the palate.

There seems to be no doubt, but that our *h*, which is the same with that of the Romans, derived its figure from that of the Hebrew ה. And, indeed, the Phœnicians, most ancient Greeks and Romans, used the same figure with our H, which in the series of all these alphabets keeps its primitive place, being the eighth letter.

H, used as a numeral, denotes 200; and with a dash over it, $\overline{\text{H}}$, 200,000.

HABEAS *corpus*, a writ, of various uses, and of different importance. It was originally a writ, which a man indicted of a trespass before justices of the peace, or in a court of franchise, and being apprehended for it, may have out of the King's Bench, to remove himself thither at his own costs, and to answer the cause there. In its more usual sense it is the most celebrated writ in the English law. The most efficacious kind, in all manner of illegal confinement, is that of *habeas corpus ad subjiciendum*, which is the subject's writ of right, in cases where he is aggrieved by illegal imprisonment, or any unwarrantable exercise of power.

This writ is founded upon common law, and has been secured by various statutes, of which the last and most efficacious, was the 31 Charles II. c. 2, which is emphatically termed the habeas act, and may justly be deemed a second magna charta, and as relates to modern times is far more efficacious, for it is the grand protection of the subject against unlawful imprisonment.

By this important statute it is enacted, that on complaint, in writing, by or on behalf of any person committed and charged with any crime (unless committed for felony or treason expressed in the warrant, or as accessary, or on suspicion of being accessary before the fact to any petit treason or felony plainly expressed in the warrant, or unless he be convicted or charged in execution by legal process), the Lord Chancellor, or any other of the twelve judges in vacation, upon viewing a copy of the warrant, or affidavit that the copy is denied, shall (unless the party have neglected for two terms to apply to any court for his enlargement) award an *habeas corpus* for such prisoner, returnable immediately before himself or any other of the judges, and upon return made, shall discharge the party, if bailable, upon giving security to appear, and answer to the accusation in the proper court of judicature.

That such writs shall be indorsed, as granted in pursuance of the act, and signed by the person awarding them. That the writ shall be returned, and the prisoner brought up within a limited time, according to the distance, not exceeding in any case twenty days. That the officers and keepers neglecting to make due returns, or not delivering to the prisoner or his agent, within six hours after demand, a copy of the warrant of commitment, or shifting the custody of a prisoner, from one to another, without sufficient reason or authority (specified in the act), shall, for the first offence, forfeit one hundred pounds, and for the second offence two hundred pounds to the party grieved, and be disabled to hold his office. That no person, once delivered by habeas corpus, shall be recommitted for the the same offence, on penalty of five hundred pounds.

That every person committing treason or felony, shall, if he require it, the first week of the next term, or the first day of the sessions of oyer and terminer, be indicted in that term or session, or else be admitted to bail, unless the king's witnesses cannot be produced at that time; and if acquitted, or if not indicted and tried in the second term or session, he shall be discharged from his imprisonment for such imputed offence; but no person, after the assize shall be open for the county in which he is detained, shall be removed by habeas corpus till after the assizes are ended, but shall be left to the justice of the judges of assize. That any such prisoner may move for and obtain his *habeas corpus*, as well out of the Chancery or Exchequer, as out of the King's Bench or Common Pleas; and the Lord Chancellor, or judges denying the same on sight of the warrant, or oath that the same is refused, shall forfeit severally to the party grieved, the sum of five hundred pounds. That this writ of habeas corpus, shall run into the counties palatine, cinque ports, and other privileged places, and the islands of Jersey, Guernsey, &c. That no inhabitants of England (except persons contracting, or convicts praying to be transported, or having committed some capital offence in the place to which they are sent) shall be sent prisoners to Scotland, Ireland, Jersey, Guernsey, or any places beyond the seas, within or without the King's dominions, on pain that the party committing, his advisers, aiders, and assistants, shall forfeit to the party grieved a sum not less than five hundred pounds, to be recovered with treble costs, shall be disabled to bear any office of trust or profit, shall incur the penalties of premunire, and shall be incapable of the King's pardon.

The writ of habeas corpus being an high prerogative writ, issues out of the King's Bench or Common Pleas, not only in term, but in vacation, by a fiat from the chief justice, or any other judge; and runs into all parts of the King's dominions. If it issues in vacation, it is usually returnable before the judge himself who awarded it, and he proceeds by himself thereon, unless the term should intervene, when it may be returned in court.

To obtain this writ, application must be made to the court by motion, as in the case of all other prerogative writs. This writ may also be obtained to remove every unjust restraint or personal freedom in private life, though imposed by an husband, or a father; but when women or infants are brought up by habeas corpus, the court will set them free from an unmerited or unreasonable confinement, and will leave them at liberty to choose where they will go.

The habeas corpus *ad subjiciendum* is a prerogative writ, and also, in regard to the subject, is his writ of right, to which he is entitled to *ex debito justiciæ*, being in nature of writ of error to examine the legality of the commitment, and commanding the day, the caption, and cause of detention to be returned.

The habeas corpus *ad faciendum et recipiendum* issues only in civil cases, and lies where a person is sued, and in gaol, in some inferior jurisdiction, and is willing to have the cause determined in some superior court; in this case the body is to be removed by *habeas corpus*, but the proceedings must be removed by *certiorari*. This writ suspends the power of the court below; so that if it proceeds after, the proceedings are void, and deemed *coram non judice*. The proceedings in the inferior court are, in fact, at an end; for the person of the defendant being removed to the superior court, they have lost their jurisdiction over him, and all the proceedings in the superior court are *de novo*, so that bail *de novo* must be put in, in the superior court.

Habeas corpus *ad respondendum* is where a man hath a cause of action against one who is confined by the process of some inferior court; in which case, this writ is granted to remove the prisoner to answer this new action in the court above, which is often done to remove a prisoner from the prison of the Fleet into the King's Bench, and *vice versa*.

Habeas corpus *ad deliberandum, et recipiendum*, is a writ which lies to remove a person to the proper place or county where he committed some criminal offence.

Habeas corpus *ad satisfaciendum* lies after a judgment, when the party wishes to bring up a prisoner to charge him in execution in the inferior court.

Habeas corpus upon a *cepi* lies where the party is taken in execution in the court below.

Habeas corpus *ad testificandum* lies to remove a person in confinement, in order to give his testimony in a cause depending.

These are all writs, in civil cases, to bring the party into court for a special purpose, and are mere ordinary processes; but

the grand writ by which the liberty of the subject is secured, is that of the habeas corpus mentioned first, which is justly deemed a palladium of British liberty. Its efficacy consists in the right that every man has to have his cause of commitment publicly stated and inquired into by the lawful judges of the land, according to the ordinary rules of law, and it provides not only against the oppression and cruelty, but also against the indolence and ignorance of a government; for it is well observed by Blackstone, that under a despotic authority, and when the habeas corpus act has been suspended, the unfortunate persons who have been confined have been too often suffered to linger, because they were forgotten. One important use of the habeas corpus, to which it is now daily applied, is in bringing up seamen who have been impressed, to ascertain whether they are subject to that rigorous authority. In times of particular alarm, it has been the practice to suspend the operation of the habeas corpus act, and it is to be feared that ministers have rather sought and made than properly found a just occasion for this measure. It is easy to cry that the church and state is in danger, and there are enough ready to take or to feign an alarm; the habeas corpus act is suspended, and men are taken up by warrants from the Secretary of State, upon mere charges of libel, or what is indefinitely called sedition, to give a colour to the harsh usurpation of power. Instances have been known where men so confined have been afterwards released without trial; because, in reality, no charge could be supported against them. In the ordinary course of law these men would be entitled to indemnity; but the minister, who has the address to procure an indemnity bill, avoids the just compensation due to injured innocence, and the man who has been ruined by an unjust charge is without redress. Surely, when these are the possible consequences of a suspension of the habeas corpus act, every Briton ought to resist it. If crimes are committed the law has vigour to punish. The habeas corpus is the protection only of the innocent, and they should never be deprived of it.

With respect to removing civil causes out of inferior courts by habeas corpus, there are some useful restrictions, such as that they shall not be removed, if the debt or damages be less than 5*l.*, &c.

HABENDUM, in a deed, that formal part of it which is to determine what estate or interest is granted by it, the certainty thereof, for what time, and to what use. It is expressed by the words "to have and to hold for such a term," &c. It sometimes qualifies the estate, so that the general extent which, by construction of law, passes by the words used in the premises, may by the habendum be controlled. The habendum may, therefore, lessen or enlarge the estate previously granted, but it cannot totally contradict or be repugnant to it. As if a grant be to one, and the heirs of his body, habendum, to have to him and his heirs for ever, here he has an estate tail by the grant; and by the habendum a fee-simple expectant thereon. But if it had been in the premises to him and his heirs to have for life, the habendum would be utterly void: for an estate of inheritance is vested in him before the habendum comes, and shall not afterwards be taken away, or divested by it. The habendum cannot pass any thing that is not expressly mentioned, or contained by implication, in the premises of the deed; because the premises being part of the deed by which the thing is granted, and consequently that makes the gift; it follows, that the habendum, which only limits the certainty and extent of the estate in the thing given, cannot increase or multiply the gift, because it were absurd to say, that the grantee shall hold a thing which was never given him. See DEED.

HABIT, in philosophy, an aptitude or disposition either of mind or body, acquired by a frequent repetition of the same act.

HACKLE, an implement used in dressing flax.

HÆMANTHUS, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Spathaceæ. Narcissi, Jussieu. Essential character: involucre six-leaved, many-flowered; corolla six-parted, superior; berry three-celled. There are eight species.

HÆMATOPUS, the *Oyster-catcher*, in natural history, a genus of birds of the order Grallæ. Generic character: bill compressed, the tip an equal wedge; nostrils linear; tongue about a third part of the length of the bill; toes three; all placed forwards, the outer one joined to the middle by a strong membrane. This bird is sixteen inches in length, and about the size of a crow; it is to be met with on almost every sea-shore, and is rather common in Great Britain, particularly on the Western coast. In the winter season, these birds are seen in considerable flocks, but in sum-

mer, only in pairs. The female prepares no nest, but deposits her eggs on the naked shore, a little above high-water mark. If the oyster-catcher be taken young, it is tamed with great ease, and will accompany the ducks to the ponds, and the poultry in general to their roosts. The general food of these birds, in their natural state, consists of shell-fish; they will, with astonishing ease, force the limpet from the rock, notwithstanding its tenacious hold, and, on perceiving the slightest aperture of its shells by an oyster, they insert their bills in it with admirable dexterity, and tear the tenant from his mansion. See Aves, Plate VII. fig. 6.

HÆMATOXYLUM, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five-parted; petals five; legume lanceolate; valves boat-shaped. There is but one species, *viz.* H. campecheinum, logwood, blood-wood, or campeche-wood. This tree grows naturally in the bay of Campeche, at Honduras, and many parts of the Spanish West Indies, where it frequently rises to four-and-twenty feet in height.

HÆMORRHOIDS, or *Piles*. See MEDICINE.

HÆRUCA, in natural history, a genus of the Vermes Intestina class and order. Body round, the fore-part two-necked, and surrounded with a single row of prickles, without any proboscis. Only one species is mentioned by Gmelin, *viz.* the H. muris, which inhabits the intestines of the mouse, and is distinguished from the genus Echinorhynchus, by being destitute of the retractile proboscis.

HAIL, in natural history, a meteor generally defined frozen rain, but differing from it, in that the hailstones are not formed of single pieces of ice, but of many little spherules agglutinated together; neither are these spherules all of the same consistence; some of them being hard and solid, like perfect ice; others soft, and mostly like snow hardened by a severe frost. Hailstone has a kind of core of this soft matter; but more frequently the core is solid and hard, while the outside is formed of a softer matter. Hailstones assume various figures, being sometimes round, at other times pyramidal, crenated, angular, thin, and flat, and sometimes stellated with six radii, like the small crystals of snow. Natural historians furnish us with various accounts of surprising showers of hail, in which the hailstones were of extraordinary magnitude. Of these we mention one or two, said to have happened in our own country.

"Dr. Halley, and others also, relate, that in Cheshire, Lancashire, &c., April 29th, 1697, a thick, black cloud, coming from Carnarvonshire, disposed the vapours to congeal in such a manner, that, for about the breadth of two miles, which was the limit of the cloud, in its progress for the space of sixty miles, it did inconceivable damage; not only killing all sorts of fowls and other small animals, but splitting trees, knocking down horses and men, and even ploughing up the earth; so that the hailstones buried themselves under ground, an inch or an inch and a half deep. The hailstones, many of which weighed five ounces, and some half a pound, and, being five or six inches about, were of various figures; some round, others half round; some smooth, others embossed and crenated; the icy substance of them was very transparent and hard, but there was a snowy kernel in the middle of them.

"In Hertfordshire, May 4, the same year, after a severe storm of thunder and lightning, a shower of hail succeeded, which far exceeded the former; some persons were killed by it, and their bodies beaten all black and blue; vast oaks were split, and fields of rye cut down as with a scythe. The stones measured from ten to thirteen or fourteen inches about. Their figures were various, some oval, others picked, and some flat." Phil. Trans. Number 229. See METEOROLOGY.

HAILING, in naval language, the salutation or accosting a ship at a distance, which is usually performed with a speaking-trumpet: the first exclamation is "hoa, the ship, a hoay," to which she replies "holloa;" then follow the requisite questions and replies.

HAIR, small filaments issuing out of the pores of the skins of animals, and serving most of them as a tegument or covering. In lieu of hair, the nakedness of some animals is covered with feathers, wool, scales, &c. Hair is found on all parts of the human body, except the soles of the feet and the palms of the hands; but it grows longest on the head, chin, breast, in the armpits, &c. It is known that every hair does properly and truly live, and receive nutriment to fill and distend it like the other parts; which they argue hence, that the roots do not turn grey in aged persons sooner than

the extremities, but the whole changes colour at once, and the like is observed in boys, &c.; which shows, that there is a direct communication, and that all the parts are affected alike. It may be observed, however, that, in propriety, the life and growth of hairs is of a different kind from that of the rest of the body, and is not immediately derived therefrom, or reciprocated therewith. It is rather of the nature of vegetation. They grow as plants do out of the earth; or, as some plants shoot from the parts of others, from which though they draw their nourishment, yet each has, as it were, its several life, and a distinct economy. They derive their food from some juices in the body, but not from the nutritious juices; whence they may live though the body be starved.

The hairs ordinarily appear round or cylindrical; but the microscope also discovers triangular and square ones, which diversity of figure arises from that of the pores, to which the hairs always accommodate themselves. Their length depends on the quantity of the proper humour to feed them, and their colour on the quality of that humour: whence, at different stages of life, the colour usually differs. Their extremities split into two or three branches, especially when kept dry, or suffered to grow too long; so that what appears only a single hair to the naked eye, seems a brush to the microscope. The hair of a mouse, viewed by Mr. Derham with a microscope, seemed to be one single transparent tube, with a pith made up of fibrous substances, running in dark lines, in some hairs transversely, in others spirally. The darker medullary parts or lines, he observes, were no other than small fibres convolved round, and lying closer together than in the other parts of the hair; they run from the bottom to the top of the hair, and, he imagines, may serve to make a gentle evacuation of some humour out of the body: hence, the hair of hairy animals, this author suggests, may not only serve as a fence against cold, &c., but as an organ of insensible perspiration. Hair makes a very considerable article in commerce, especially since the mode of perukes has obtained. The hair of the growth of the northern countries, as England, &c. is valued much beyond that of the more southern ones, as Italy, Spain, the south parts of France, &c. The merit of good hair consists in its being well fed, and neither too coarse nor too slender; the bigness rendering it less susceptible of the artificial curl, and disposing it rather to frizzle, and the smallness making its curl of too short duration. Its length should be about twenty-five inches; the more it falls short of this, the less value it bears.

The scarceness of grey and white hair, has put the dealers in that commodity upon the methods of reducing other colours to these. This is done by spreading the hair to bleach on the grass like linen, after first washing it out in a bleaching water: this ley, with the force of the sun and air, brings the hair to so perfect a whiteness, that the most experienced person may be deceived therein; there being scarce any way of detecting the artifice, but by boiling and drying it, which leaves the hair of the colour of a dead walnut-tree leaf. Hair, like wool, may be dyed of any colour.

Hair which does not curl or buckle naturally, is brought to it by art, by first boiling, and then baking it, in the following manner: after having picked and sorted the hair, and disposed it in parcels according to lengths, they roll them up, and tie them tight down upon little cylindrical instruments, either of wood or earthen ware, a quarter of an inch thick, and hollowed a little in the middle, called pipes; in which state they are put in a pot over the fire, there to boil for about two hours. When taken out, they let them dry; and, when dried, they spread them on a sheet of brown paper, cover them with another, and thus send them to the pastry-cook, who, making a crust or coffin around them, of common paste, sets them in an oven till the crust is about three-fourths baked. The end by which a hair grows to the head, is called the head of the hair; and the other, with which they begin to give the buckle, the point. Formerly the peruke-makers made no difference between the ends, but curled and wove them by either indifferently; but this made them unable to give a fine buckle; hair woven by the point never taking a right curl.

Hair is also used in various other arts and manufactures: in particular, the hair of beavers, hares, conies, &c. is the principal matter whereof hats are made. Spread on the ground, and left to putrify on cornlands, hair, as all other animal substances, *viz.* horns, hoofs, blood, &c. proves good manure.

This, like every part of the animal system, has been chemically analysed, and has been found to contain a large portion of gelatine, which may be separated from it by

boiling. It then becomes brittle, the gelatine being the principal cause of its suppleness and toughness. From some experiments by Mr. Hatchett, it is inferred that the hair which loses its curl in moist weather, and which is softest and most flexible, is that which yields its gelatine most readily; whereas strong and elastic hair yields it with the greatest difficulty, and in the smallest proportion. By an experiment of Berthollet's, 1,152 parts of hair yielded

Carbonate of ammonia	90
Water	179
Oil	288
Gases	271
Coal	324
	1152

The oil was soluble in alcohol, burnt with brilliancy, and with scintillations like the hair itself. The coal was attracted by the magnet, which proves it contains iron. The alkalies, at a boiling heat, dissolve hair, and form with it an animal soap. Sulphuric acid dissolves hair, with the aid of heat. Hair is usually distinguished into various kinds: the stiffest and strongest is called bristles, such as that on the backs of swine. When remarkably soft and pliable, it is denominated wool, as that on sheep; and the finest of all, is called down. From wool more than half its weight of oxalic acid is obtained. Feathers possess similar properties to those of hair; the quill is composed of coagulated albumen, but no gelatine. Muriatic acid dissolves hair, and the solution is very like a solution of glue in the same acid. When plunged into acid, in the state of gas, it is very soon converted into a pulp.

Hair, or Down, *of plants*, a general term, expressive of all the hairy and glandular appearances on the surface of plants, to which they are supposed by naturalists to serve the double purpose of defensive weapons and vessels of secretion. These hairs are minute threads, of greater or less length and solidity, some of them visible to the naked eye, whilst others are rendered visible only by the help of glasses. Examined by a microscope, almost all the parts of plants, particularly the young stalks or stems, appear covered with hairs. Hairs on the surface of plants, present themselves under various forms; in the leguminous plants, they are generally cylindric; in the mallow tribe, terminated in a point; in agrimony, shaped like a fish-hook; in nettle, awl-shaped and jointed; and in some compound flowers, with hollow or funnel-shaped florets, they are terminated in two crooked points.

Hair's *breadth*, a measure of length, being the forty-eighth part of an inch.

HAKE, in ichthyology, the English name of the gadus, with two fins on the back, and the under-jaw longest. It grows to two feet or more in length, but is the slenderest of all the gadi. See Gadus.

HALBARD, or Halbert, in the art of war, a well-known weapon, carried by the serjeants of foot and dragoons. It is a sort of spear, the shaft of which is about five feet long, and made of ash or other wood. Its head is armed with a steel point, edged on both sides, not unlike the point of a two-edged sword: but besides this sharp point, which is in a line with the shaft, there is a cross piece of steel, flat and pointed at both ends; but generally with a cutting edge at one extremity, and a bent sharp point at the other; so that it serves equally to cut down, or push withal. It is also useful in determining the ground between the ranks, and in adjusting the files of a battalion.

HALE, in the sea langauge, signifies pull; as to hale up is to pull up; to hale in or out, is to pull in or out. To over-hale a rope, is to hale it too stiff, or to hale it the contrary way.

HALES (Stephen), D. D. in biography, an eminent natural philosopher and excellent parish clergyman, was sixth son of Thomas Hales, Esq. of Beckesbourn, in Kent, where he was born in 1677. At the age of nineteen he was entered a pensioner of Bene't College, Cambridge, of which he was elected a fellow in 1702. He afterwards proceeded M. A. and entered into holy orders. During his residence at Cambridge he distinguished himself by his diligent researches into various branches of natural knowledge, particularly botany and anatomy. In these studies he had for an associate William Stukeley, afterwards M. D. and an eminent antiquary. A turn of novel and ingenious experiments, and of mechanical inventions, early characterized Mr. Hales, and a contrivance for obtaining a preparation of the lungs in lead with the construction of a planetarium upon the Newtonian system of astronomy, are mentioned among the products of his skill at this period. In 1710 he was presented to the perpetual curacy of Teddington, in Middlesex. Not long after he vacated his fellowship by accepting the living of Portlock, in Somersetshire, which he exchanged for

that of Farringdon, in Hampshire. He then married the daughter of a clergyman, who died after two years, leaving no issue. Henceforth he lived entirely as a single man, devoting himself entirely to science, and objects of public utility. In 1717 he was elected a member of the Royal Society, and in the following year he read before that body an account of some experiments concerning the effect of the sun's heat in raising the sap in vegetables. The farther prosecution of these experiments gave rise to an excellent work published in 1727, entitled "Vegetable Statics, or an account of some Statical Experiments on the Sap of Vegetables; being an Essay towards a Natural History of Vegetation: also, a Specimen of an Attempt to Analyse the Air by a variety of Chemico-Statical Experiments, which were read at several Meetings before the Royal Society," 8vo. This piece is justly esteemed a model of experimental investigation. Haller characterizes it as "liber eximus, cujus paucissimos habemus æmulos qui toties potius legi volet, quam decerpi." It begins by ascertaining the vast quantity of watery humour perspired by plants, sometimes equalling their whole weight in a single day. It then specifies the power with which they attract the nutritious juice through their capillary tubes, and considers the lateral motion of this juice from trunk to branches, and vice versa. It disproves any proper circulation of this fluid, but establishes its ascent during the day, and descent during the night. The leaves are proved to be inspiratory organs, both of air and water. There are besides a number of curious remarks upon the vegetable system, as well as upon the constitution of atmospherical air, into which he was one of the experimental enquirers. His experiments upon air relate indeed solely to its generation and absorption, its elastic and non-elastic states, and do not proceed to the discovery of any of those species of air or gases which have so much engaged the attention of modern philosophers, though they manifestly led to such discoveries. A second edition of this work appeared in 1731, and in 1733 he published, as a kind of sequel to it, his "Statical Essays, containing Hæmastatics; or an Account of some Hydraulic and Hydrostatical Experiments made on the Blood and Blood-vessels of Animals: also, an Account of some Experiments on Stones in the Kidneys and Bladder, &c." In this he discussed some fundamental points relative to physiology, as the force and celerity with which the blood is propelled in the arteries, its retardation in the capillary vessels, the area of the heart, and the weight of blood sustained by it, the effects of respiration, and the alteration of air by breathing, &c. His enquiries concerning the urinary calculus relates to its chemical composition, and to the means of dissolving it; of which, suggested by him, is fixed air, or that produced by sulphuric acid and fixed alkali in a state of effervescence. He also proposes injections into the bladder, and gives a contrivance for that purpose. This subject he afterwards pursued more particularly, and published an account of some experiments on Mrs. Stephens's celebrated medicines, in 1740. The reputation of this worthy man kept pace with his useful labours. In 1732 he was appointed one of the trustees for settling a colony in Georgia; and, in 1733, the University of Oxford presented him with the degree of D. D. He performed a valuable service to the health and morals of the poor, by printing, anonimously, "A Friendly Admonition to the Drinkers of Gin, Brandy, and other Spirituous Liquors," which has been several times reprinted and distributed gratis. In 1739 he printed "Philosophical Experiments on Sea Water, Corn, Flesh, and other Substances," 8vo. chiefly intended for the use of navigators. A paper on a similar subject, and the solution of the stone in the bladder obtained him, in the same year, the gold medal from the Royal Society. One of the most useful of Dr. Hales' invention was that of ventilators for renewing the air in mines, prisons, hospitals, and holds of ships, which he disclosed to the Royal Society in 1741. Some years afterwards his machines were fixed on the Savoy and Newgate Prisons, to the great benefit of the persons confined in them, among whom the progress of the gaol-fever was much diminished. His plans for producing a free circulation of air were also applied by him for the cleansing and preservation of corn: for the former purpose he invented a machine called a back-heaver, which he described in the Gentleman's Magazine for 1745 and 1747. His attention to medical subjects was farther evinced, by a paper read before the Royal Society, in describing a method for conveying liquors into the abdomen after tapping; by some experiments and observations on tar-water; and a detection of some fallacious boasts concerning the efficacy of a lithontriptic, called the liquid shell. A

sermon, which he preached before the College of Physicians, in 1751, on Dr. Crown's foundation, contains some curious physiological remarks relative to the benevolence of the Deity, as displayed in the human frame. His literary honours were augmented in 1753, by his election as a foreign member of the French Academy of Sciences, in the room of Sir Hans Sloane.

Dr. Hales, though he spent his time in retirement at Teddington, was not unknown to many persons of rank, whom he visited and received at his house with all the simplicity of his modest and unaffected character. Frederick, Prince of Wales, honoured himself with frequent calls upon the philosopher, his neighbour, whom he delighted to surprise in his experimental researches. At the death of that prince he was, without any solicitation, made clerk of the closet to the Princess Dowager. It was hinted to him that there was an intention of presenting him to the canonry of Windsor; but he desired to be excused accepting a promotion, which might have brought with it obligations of spending his time, interfering with the plan which for so many years he had adopted. His parochial duties, and the uninterrupted pursuit of his useful studies, continued to occupy him to an advanced period of life, during which he was never forsaken by his habitual cheerfulness and serenity of mind, sustained by temperance, piety, and conscious worth. He seems to have passed through life without an enemy, and perhaps the annals of biography cannot produce a character more marked by the union of blamelessness with active benevolence. Pope has recorded "Plain Parson Hales" as his model of sincere piety. Haller describes him as "pious, modest, indefatigable, and born for the discovery of truth." He died at Teddington, in January, 1761, in his eighty-fourth year, and was buried under the tower of the church which he had rebuilt at his own expence. The Princess of Wales erected a monument to him in Westminster Abbey, in the Latin inscription of which the reader will be surprised to find nothing recorded of him but that he was her chaplain. But the reception his works met with throughout Europe, into the principal languages of which they were translated, will sufficiently perpetuate his fame as a philosopher.

HALESIA, in botany, so named in honour of the learned and venerable Stephen Hales, D. D. F. R. S. a genus of the Dodecandria Monogynia class and order. Natural order of Bicornes. Guajacanæ, Jussieu. Essential character: calyx four-toothed, superior; corolla four-cleft; nut quadrangular, with two seeds. There are two species, *viz.* H. tetraptera, four-winged halesia, or snow-drop tree; and H. diptera, two-winged halesia.

HALF *mark*, a noble, or six shillings and eightpence.

HALF *moon*, in fortification, an outwork composed of two faces, forming a saliant angle, whose gorge is in form of a crescent, or half-moon: whence the name.

HALIOTIS, in natural history, the ear-shell. Animal a limax: shell univalve, dilated, ear-shaped, with a longitudinal row of orifices along the surface; spire lateral, and almost concealed. There are nineteen species, of which H. tuberculata is described by Mr. Donovan as a native of this country. The shell is subovate, the outside transversely grooved, rugged, and tuberculate. The inside is like mother-of-pearl. It inhabits the sea near Guernsey, and is likewise frequently cast up on the southern shores of Devonshire. When living it adheres to rocks. According to Pennant this was the sea-ear of Aristotle.

HALL, in architecture, a large room at the entrance of a fine house and palace.

HALL is also a public building or court of justice, as Westminster-hall, Guild-hall, a company's hall, &c. In Westminster-hall are held the Courts of King's Bench, Common Pleas, Chancery, and Exchequer.

HALLERIA, in botany, so called from the famous Albert Haller, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx trifid; corolla quadrifid; filaments longer than the corolla; berry inferior, two-celled. There is but one species, *viz.* H. lucida, African fly-honeysuckle, a native of the Cape.

HALLIARDS, in sea language, the ropes or tackles usually employed to hoist or lower any sail upon its respective masts or stay.

HALO, in physiology, a meteor in the form of a luminous ring or circle, of various colours, appearing round the bodies of the sun, moon, or stars. See METEOROLOGY.

HALORAGIS, in botany, a genus of the Octandria Tetragynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character: calyx four-

cleft, superior; petals four; drupe dry, inclosing a four-celled nut. There are two species, *viz.* H. prostrata and H. cercodia.

HAMAMELIS, in botany, a genus of the Tetrandria Digynia class and order. Natural order of Berberides, Jussieu. Essential character: involucre three-leaved; perianthers four-leaved; petals four; nut two-horned, two-celled. There is only one species, *viz.* H. virginica, witch hazel.

HAMELIA, in botany, so called from Jean Baptiste du Hamel du Monceau, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: corolla five-cleft; berry five-celled, inferior, many-seeded. There are four species, all natives of the West Indies.

HAMMER, a well known tool used by mechanics, consisting of an iron head, fixed cross-wise upon a handle of wood.

There are several sorts of hammers used by blacksmiths; as, 1. The hand-hammer, which is of such weight that it may be wielded or governed with one hand at the anvil. 2. The up-hand sledge, used with both hands, and seldom lifted above the head. 3. The about-sledge, which is the biggest hammer of all, and held by both hands at the farthest end of the handle, and being swung at arms-length over the head, is made to fall upon the work with as heavy a blow as possible. There is also another hammer used by smiths, called a rivetting-hammer, which is the smallest of all, and is seldom used at the forge, unless upon small work.

HAMMOCK, in naval affairs, a piece of hempen cloth six feet long and three feet wide, gathered together at the two ends by means of a clue, and slung horizontally under the deck, forming a receptacle for a bed. There are about from fourteen to twenty inches in breadth allowed between the decks for every hammock in a ship of war. In preparing for battle, the hammocks, with their contents, are all firmly corded, taken upon deck, and fixed in various nettings, so as to form a barricade against small shot.

HAMSTER. See Mus.

HANAPER *office*, in the Court of Chancery, is that out of which all original writs issue that pass under the great seal, and all commissions of charitable uses, sewers, bankrupts, idiocy, lunacy, and the like. These writs, relating to the business of the subject, and the returns to them, were originally kept in a hamper, *in hanaperio*; the other writs, relating to such matters wherein the crown is immediately or mediately concerned, were preserved in a little sack or bag, *in parva baga*; and thence arises the distinction of the hanaper office, and petty bag office; both of which belong to the common law court in Chancery

HAND. See Anatomy.

Hand *breadth*, a measure of three inches. By this standard the height of horses is estimated.

Hand *cuffs*, an instrument formed of two circular pieces of iron, each fixed on a hinge on the ends of a very short iron bar, which being locked over the wrists of a malefactor, prevents his using his hands.

Hand *spikes*, wooden levers used at sea to traverse the ordnance, or to turn the windlass in weighing up the anchor, &c. They are more commodious than iron crows, because their length allows a better poize.

Hands, in heraldry, are borne in coat-armour dexter and sinister, that is, right and left, expanded or open. These are the most necessary parts of the human body, as they serve to express all sorts of actions, and even our very thoughts and designs; thus joining of hands is an universal token of friendship, and clapping of hands a general mark of applause.

HANKS, in naval affairs, are wooden rings fixed upon the stays to confine stay-sails at different distances. They are in place of gromets, being more convenient as well as of a later invention. They are formed by bending a tough piece of wood into the form of a wreath, and fastened at the two ends by means of notches, thereby retaining their circular figure and elasticity, whereas the gromets, which are formed of rope, are apt to relax in warm weather, and which adhere.

HANSE *towns*, port-towns of Germany, of which Lubec and Hamburgh were the chief. They were formerly all of them imperial cities, confederated for their mutual defence, and the protection of their trade.

HARBOUR, a place where ships may ride safe at anchor, chiefly used in speaking of those secured by a boom and chain, and furnished with a mole. The bottom of a good harbour should be free from rocks and shallows: the entrance should be of sufficient extent to admit large ships: it should have good anchoring ground, and be easy of access; it should have room and convenience to receive the shipping of different nations: it

should be furnished with a good light-house, and have at command plenty of wood and other materials for firing, besides hemp, iron, &c.

Harbour *master*, an officer appointed to inspect the moorings, and to see that the laws and regulations of the harbour are strictly attended to by the different ships.

HARDNESS, in physiology, is the resistance opposed by a body to the separation of its particles. This property depends on the force of cohesion, or on that which chemists call affinity, joined to the arrangement of the particles to their figure and other circumstances. A body, says M. Hauy, is considered more hard in proportion as it presents greater resistance to the friction of another hard body, such as a steel file; or as it is more capable of wearing or working into such other body to which it may be applied by friction. Lapidaries judge of the hardness of fine stones, &c. from the difficulty with which they are worn down or polished.

HARE. See Lepus.

HARIOT, or Heriot, in law, a due belonging to a lord at the death of his tenant, consisting of the best beast, either horse, ox, or cow, which he had at the time of his death; and in some manors, the best goods, piece of plate, &c. are called hariots.

There is both hariot-service, and hariot-custom: when a tenant holds by service to pay a hariot at his decease, which is expressly reserved in the deed of feoffment, this is a hariot service; and where hariots have been customarily paid time out of mind after the death of a tenant for life, this is termed hariot custom. For hariot-service, the lord may distrain any beast belonging to the tenant that is on the land. For hariot-custom, the lord is to seise not distrain; but he may seise the best beast that belonged to the tenant, though it be out of the manor, or in the king's highway, because he claims it as his proper goods by the death of his tenant. Nevertheless where a woman marries and dies, the lord shall have no hariot-custom, because a feme-covert has no goods to pay as a hariot.

HARMATTAN, the name given to a singular wind which blows periodically from the interior parts of Africa towards the Atlantic ocean. It prevails in December, January, and February, and is generally accompanied with a fog or haze that conceals the sun for whole day's together. Extreme dryness is the characteristic of this wind: no dew falls during its continuance, which is sometimes for a fortnight or more. The whole vegetable creation is withered, and the grass becomes at once like hay. The natives take the opportunity which this wind gives them of clearing the land by setting fire to trees and plants in this their exhausted state. The dryness is so extreme that household furniture is damaged, and the wainscot of the rooms flies to pieces. The human body is also affected by it, so as to cause the skin to peel off, but in other respects it is deemed salutary to the constitution, by stopping the progress of infection, and curing almost all cutaneous diseases.

HARMONICA, or armonica, is a name which Dr. Franklin has given to a musical instrument constructed with drinking-glasses. It is well known that a drinking-glass yields a sweet tone, by passing a wet finger round its brim. Mr. Pockrich, of Ireland, was the first who thought of playing tunes formed of these tones. He collected a number of glasses of different sizes, fixed them near each other on a table, and tuned them by putting into them water, more or less, as each note required. Mr. Delaval made an instrument in imitation, and from this instrument Dr. Franklin took the hint of constructing his Armonica. The glasses for this musical instrument are blown as nearly as possible in the form of hemispheres, having each an open neck or socket in the middle. The thickness of the glass near the brim is about one tenth of an inch, increasing towards the neck, which in the largest glasses is about an inch deep, and an inch and a half wide within; but these dimensions lessen as the size of the glasses diminish, only observing that the neck of the smallest should not be shorter than half an inch. The diameter of the largest glass is nine inches, and that of the smallest three inches: between these there are twenty-three different sizes, differing from each other a quarter of an inch in diameter. For making a single instrument there should be at least six glasses blown of each size, and out of these thirty-seven glasses (which are sufficient for three octaves with all the semitones) may be found, that will either yield the note required, or one a little sharper, and fitting so well into each other, as to taper regularly from the largest to the smallest. The glasses being chosen, and the note for which each glass is intended being marked

upon it with a diamond, they are to be tuned by diminishing the thickness of those that are too sharp, which is done by grinding them round from the neck towards the brim; comparing, by means of a well-tuned harpsichord, the tone drawn from the glass by your finger with the note you want, as sounded by the corresponding string of the harpsichord. The largest glass in the instrument is G, a little below the reach of a common voice, and the highest G, including three complete octaves; and they are distinguished by painting the apparent parts of the glasses within side, every semitone white, and the other notes of the octave with the seven prismatic colours; so that glasses of the same colour (the white excepted) are always octaves to each other. When the glasses are tuned, they are to be fixed on a round spindle of hard iron, an inch in diameter at the thickest end, and tapering to a quarter of an inch at the smallest. For this purpose the neck of each glass is fitted with a cork, projecting a little without the neck: these corks are perforated with holes of different diameters, according to the dimension of the spindle in that part of it where they are to be fixed. The glasses are all placed within one another; the largest on the biggest end of the spindle, with the neck outwards; the next in size is put into the other, leaving about an inch of its brim above the brim of the first; and the others are put on in the same order. From these exposed parts of each glass the tone is drawn, by laying a finger upon one of them as the spindle and glasses turn round. The spindle, thus prepared, is fixed horizontally in the middle of a box, and made to turn on brass gudgeons at each end. A square shank comes from its thickest end through the box, on which shank a wheel is fixed by a screw: this will serve, like a fly, to make the motion equable, when the spindle is turned by the foot like a spinning-wheel. The wheel is eighteen inches in diameter, and conceals near its circumference about twenty-five pounds of lead, and may be made of mahogany. An ivory pin is fixed in the face of the wheel, about four inches from the axis; over which is put the loop of the string that comes up from the moveable step to give it motion. The box is about three feet long, eleven inches wide at the biggest end, and five inches at the smallest end; it is made with a lid, which opens at the middle of its height, and turns up by back-hinges. The instrument, thus completed, stands on a neat frame with four legs. This instrument is played upon by sitting before it, as before the keys of a harpsichord, turning the spindle with the foot, and wetting the glasses, now and then, with a sponge and clean water. The fingers should be first soaked in water; and rubbed occasionally with fine chalk, to make them catch the glass, and bring out the tone more readily. Different parts may be played together by using both hands; and the tones are best drawn out when the glasses turn from the ends of the fingers, not when they turn to them. The advantages of this instrument, says Dr. Franklin, are, that its tones are incomparably sweet beyond those of any other; and that they may be swelled and softened at pleasure by stronger or weaker pressures of the finger; and continued to any length: and, when it is once well tuned, it never again wants tuning. Franklin's Letters, &c.

HARMONICAL *arithmetic*, that part of arithmetic which considers musical intervals, expressed by numbers, in order to our finding their mutual relations, compositions, and resolutions.

HARMONICAL *composition*, in a general sense, includes both harmony and melody, *i. e.* of music or songs, both in a single part, and in several parts. In its more proper and limited sense, harmonical composition is restrained to that of harmony; and may be defined the art of disposing and concerting several single parts together, so as to make one agreeable whole.

HARMONICAL *interval*, in music, denotes the difference of two sounds, which is agreeable to the ear, whether in consonance or succession; and are, therefore, the same with concord.

HARMONICAL *proportion*, or *musical proportion*, is that in which the first term is to the third, as the difference of the first and second is to the difference of the second and third; or when the first, the third, and the said two differences, are in geometrical proportion. Or, four terms are in harmonical proportion when the first is to the fourth as the difference of the first and second is to the difference of the third and fourth. Thus 2, 3, 6, are in harmonical proportion, because 2 : 6 :: 1 : 3. And the four terms 9, 12, 16, 24 are in harmonical proportion, because 9 : 24 :: 3 : 8. If the proportional terms be continued in the former case, they will form an harmonical progression, or series. 1. The reciprocals of an arithmetical progression are in harmonical progres-

sion; and, conversely, the reciprocals of harmonicals are arithmeticals. Thus, the reciprocals of the harmonicals 2, 3, 6, are $\frac{1}{2}, \frac{1}{3}, \frac{1}{6}$, which are arithmeticals; for $\frac{1}{2} - \frac{1}{3} = \frac{1}{6}$, and $\frac{1}{3} - \frac{1}{6} = \frac{1}{6}$ also: and the reciprocals of the arithmeticals 1, 2, 3, 4, &c. are $\frac{1}{1}, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}$, &c. which are harmonicals; for $\frac{1}{1} : \frac{1}{3} :: \frac{1}{1} - \frac{1}{2} : \frac{1}{2} - \frac{1}{3}$; and so on. And, in general, the reciprocals of the arithmeticals $a, a+d, a+2d, a+3d$, &c. viz. $\frac{1}{a}, \frac{1}{a+d}, \frac{1}{a+2d}, \frac{1}{a+3d}$, &c. are harmonicals; *et e contra*. 2. If three or four numbers in harmonical proportion be either multiplied or divided by some number, the products, or the quotients, will still be in harmonical proportion. Thus, the harmonicals 6, 8, 12, multiplied by 2, give 12, 16, 24, or divided by 2, give 3, 4, 6, which are also harmonicals. 3. To find a harmonical mean proportional between two terms: divide double their product by their sum. 4. To find a third term in harmonical proportion to two given terms: divide their product by the difference between double the first term and the second term. 5. To find a fourth term in harmonical proportion to three terms given: divide the product of the first and third by the difference between double the first and the second term. Hence, of the two terms a and b the harmonical mean is $\frac{2ab}{a+b}$; the third harmonical proportion is $\frac{ab}{2a-b}$, also to a, b, c, the fourth harmonical is $\frac{ac}{2a-b}$. 6. If there be taken an arithmetical mean and a harmonical mean between any two terms, the four terms will be in geometrical proportion. Thus, between 2 and 6 the arithmetical mean is 4, and the harmonical mean is 3; and hence 2 : 3 :: 4 : 6. Also, between a and b the arithmetical mean is $\frac{a+b}{2}$, and the harmonical mean is $\frac{2ab}{a+b}$; but $a : \frac{2ab}{a+b} :: \frac{a+b}{2} : b$.

Harmonical *series*, a series of many numbers in continual harmonical proportion. Thus, if there are four or more numbers, of which every three immediate terms are harmonical, the whole will make an harmonical series: such is 30 : 20 : 15 : 12 : 10. Or, if every four terms immediately next each other are harmonical, it is also a continual harmonical series, but of another species, as 3, 4, 6, 9, 18, 36, &c.

Harmonical *sounds*, an appellation given to such sounds as always make a determinate number of vibrations in the time that one of the fundamentals, to which they are referred, makes one vibration.

Harmonical sounds are produced by the parts of chords, &c. which vibrate a certain number of times, while the whole chord vibrates once.

The relations of sounds had only been considered in the series of numbers, 1 : 2, 2 : 3, 3 : 4, 4 : 5, &c. which produced the intervals called octave, fifth, fourth, third, &c. M. Sauveur first considered them in the natural series, 1, 2, 3, 4, 5, &c. and examined the relations of sounds arising therefrom. The result is, that the first interval, 1 : 2, is an octave; the second, 1 : 3, a twelfth; the third, 1 : 4, a fifteenth, or double octave; the fourth, 1 : 5, a seventeenth; the fifth, 1 : 6, a nineteenth, &c.

The new consideration of the relations of sounds is more natural than the old one; and is, in effect, all the music that nature makes without the assistance of art.

HARMONICS, that part of music which considered the differences and proportions of sounds, with respect to acute and grave; in contradistinction to rhyme and metre.

HARMONY, in music, the agreeable result, or union, of several musical sounds, heard at one and the same time; or the mixture of divers sounds, which together have an effect agreeable to the ear. As a continued succession of musical sounds produces melody, so does a continued combination of these produce harmony. See Music.

Harmony *of the spheres*, or *Celestial Harmony*, a sort of music much talked of by many of the ancient philosophers and fathers, supposed to be produced by the sweetly-tuned motions of the stars and planets. This harmony they attributed to the various proportionate impressions of the heavenly globes upon one another, acting at proper intervals. It is impossible, according to them, that such prodigious large bodies, moving with so much rapidity, should be silent; on the contrary, the atmosphere, continually impelled by them, must yield a set of sounds proportionate to the impression it receives; consequently as they do not all run the same circuit, nor

with one and the same velocity, the different tones arising from the diversity of motions, directed by the hand of the Almighty, must form an admirable symphony, or concert. They therefore supposed, that the moon, as being the lowest of the planets, corresponded to *mi*; Mercury, to *fa*; Venus, to *sol*; the sun, to *la*; Mars, to *si*; Jupiter, to *ut*; Saturn, to *re*; and the orb of the fixed stars, as being the highest of all, to *mi*, or the octave.

HARP, a musical instrument of the string kind, of a triangular figure, held upright between the legs of the person who plays upon it. See MUSICAL INSTRUMENTS.

HARP, *Eolian*. See ACOUSTICS.

HARPINGS, in a ship, properly denote her breadth at the bow. Some also give the same name to the ends of the bends that are fastened into the stern.

HARPSICHORD, the most harmonious of all the musical instruments of the string-kind. It is played on after the manner of the organ, and is furnished with a set, and sometimes with two sets, of keys; the touching or striking of these keys move a kind of jacks, which also move a double row of chords, or strings, of brass or iron, stretched over four bridges, on the table of the instrument. See MUSIC.

HARPOON, sometimes called harping-iron, a spear or javelin, used to strike the whales in the Greenland and South Sea fisheries. It is furnished with a long shank, and has, at the one end, a broad and flat triangular head, sharpened at both edges, so as to penetrate the whale with facility: to the other end of this weapon is fastened a long cord, called the whale-line, which lies carefully coiled in the boat, so as to run out without being entangled. See FISHERY, *whale*.

The gun-harpoon is a weapon used for the same purpose, but is fired out of a gun, instead of being thrown by hand. It is made of steel, and has a chain attached to it, to which the line is fastened.

HARTSHORN, *spirit of*. See AMMONIA.

HARTOGIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx five-cleft; petals four, spreading; drupe ovate, inclosing two seeds. There is but one species, *viz.* H. capensis, found in the woods near the Cape of Good Hope.

HARVEST *fly*, in zoology, a large four-winged fly, of the cicada kind. See CICADA.

HASSELQUISTIA, in botany, so named, in memory of Frederick Hasselquist, M. D. a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: corolla radiated, in the disk, male: seeds in the circumference double, with a notched edge; in the disk solitary, pitcher-shaped, hemispherical. There are two species.

HAT *making*. The materials for making hats, are rabbit's fur, cut off from the skin, after the hairs have been plucked out, together with wool and beaver.

The two former are mixed in various proportions, and of different qualities, according to the value of the article intended to be made; and the latter is universally used for facing the finer articles, and never for the body or main stuff. Experience has shewn that these articles cannot be evenly, and well felted together, unless all the fibres be first separated, or put into the same state with regard to each other. This is the object of the first process, called bowing. The materials, without any previous preparation, are laid upon a platform of wood, or of wire, somewhat more than four feet square, called a hurdle, which is fixed against the wall of the work-shop, and is enlightened by a small window, and separated by two side partitions from other hurdles, which occupy the rest of the space along the wall. The hurdle, if of wood, is made of deal planks not quite three inches wide, disposed parallel to the wall, and at the distance of one-fortieth, or one fiftieth of an inch from each other, for the purpose of suffering the dust, and other impurities of the stuff, to pass through; a purpose still more effectually answered by the hurdle of wire.

The workman is provided with a bow, a bow-pin, a basket, and several cloths. The bow is a pole of yellow deal-wood, between seven and eight feet long, to which are fixed two bridges, somewhat like that which receives the hair in the bow of the violin. Over these are stretched a catgut, about one-twelfth part of an inch in thickness. The bow-pin is a stick with a knob, and is used for plucking the bow-string. The basket is a square piece of ozier work, consisting of open strait bars with no crossing or interweaving. Its length across the bars may be about two feet, and its breadth eighteen inches.

The sides into which the bars are fixed

are slightly bended into a circular curve, so that the basket may be set upright on one of these edges near the right hand end of the hurdle, where it usually stands. The cloths are linen and dyed of a dark olive brown. Besides these implements, the workman is also provided with brown paper.

The bowing commences by shovelling the materials towards the right hand partition with the basket, upon which, the workman holding the bow horizontally in his left hand, and the bow-pin in his right, lightly places the bow-string, and gives it a pluck with the pin. The string in its return, strikes part of the fur, and causes it to rise, and fly partly across the hurdle in a light open form. By repeated strokes, the whole is thus subjected to the bow, and this beating is repeated till all the original clots or masses of the filaments are perfectly opened and separated. The quantity thus treated at once, is called a batt, and never exceeds half the quantity required to make one hat.

When the batt is sufficiently bowed, it is ready for hardening, which term denotes the first commencement of felting. The prepared material being evenly disposed on the hurdle, is first pressed down by the convex side of the basket, then covered with a cloth, and pressed successively in its various parts by the hands of the workman. The pressure is gentle, and the hands are very slightly moved backwards and forwards, at the same time, through a space of perhaps a quarter of an inch, to favour the hardening or entangling of the fibres. In a very short time, indeed, the stuff acquires sufficient firmness to bear careful handling. The cloth is then taken off, and a sheet of paper, with its corners doubled in, so as to give it a triangular outline, is laid upon the batt, which last is folded over the paper as it lies, and its edges, meeting one over the other, form a conical cap.

The joining is soon made good by pressure with the hands on the cloth. Another batt, ready hardened, is in the next place laid on the hurdle, and the cap here mentioned placed upon it with the joining downwards. This last batt being also folded up, will consequently have its place of junction diametrically opposite that of the inner felt, which it must therefore greatly tend to strengthen. The principal part of the hat is thus put together, and now requires to be worked with the hands a considerable time upon the hurdle, the cloth being also occasionally sprinkled with clear water. During the whole of this operation, which is called basoning, the article becomes firmer and firmer and contracts in its dimensions. It may easily be understood, that the chief use of the paper is to prevent the sides from felting together.

The basoning is followed by a still more effectual continuation of the felting, called working. This is done in another shop, at an apparatus called a battery, consisting of a kettle (containing water slightly acidulated with sulphuric acid, to which, for beaver hats, a quantity of the grounds of beer is added, or else plain water for rinsing out), and eight planks of wood joined together in the form of a frustrum of a pyramid, and meeting in the kettle at the middle. The outer or upper edge of each plank is about two feet broad, and rises a little more than two feet and a half above the ground; and the slope towards the kettle is considerably rapid, so that the whole battery is little more than six feet in diameter. The quantity of sulphuric acid added to the liquor is not sufficient to give a sour taste, but only renders it rough to the tongue. In this liquor, heated rather higher than unpractised hands could bear, the article is dipped from time to time, and then worked on the planks with a roller, and also by folding or rolling it up, and opening it again; in all which, a certain degree of care is at first necessary to prevent the sides from felting together; of which, in the more advanced stages of the operation, there is no danger. The imperfections of the work now present themselves to the eye of the workman, who picks out the knots, and other hard substances with a bodkin, and adds more felt upon all such parts as require strengthening.

This added felt is patted down with a wet brush, and soon incorporates with the rest. The beaver is laid on towards the conclusion of this kind of working. Some workmen say that the beer grounds used with beaver hats, by rendering the liquor more tenacious, the hat is enabled to hold a greater quantity of it, for a longer time; but others say that the mere acid and water would not adhere to the beaver facing, but would roll off immediately when the article was laid on the plank. It is probable that the manufacturers who now follow the established prac-

tice, may not have tried what are the inconveniences this addition is calculated to remove.

The acid, no doubt, gives a roughness to the surface of the hair, which facilitates the mechanical action of felting. Nitrous acid is used in a process called carrotting; in this operation the material is put into a mixture of the nitrous and sulphuric acids in water, and kept in the digesting heat of a stove all night. The hair acquires a ruddy or yellow colour, and loses part of its strength. It must be remembered that our hat still possesses the form of a cone, and that the whole of the several actions it has undergone have only converted it into a soft flexible felt, capable of being extended, though with some difficulty, in every direction. The next thing to be done is to give it the form required by the wearer. For this purpose, the workman turns up the edge or rim to the depth of about an inch and a half, and then returns the point back again through the centre or axis of the cap, so far as not to take out this fold, but to produce another inner fold of the same depth. The point being returned back again in the same manner produces a third fold; and thus the workman proceeds until the whole has acquired the appearance of a flat circular piece, consisting of a number of concentric undulations or folds, with the point in the centre. This is laid upon the plank, where the workman, keeping the piece wet with the liquor, pulls out the point with his fingers, and presses it down with his hand, at the same time turning it round on its centre in contact with the plank, till he has, by this means, rubbed out a flat portion equal to the intended crown of the hat. In the next place he takes a block, to the crown of which he applies the flat central portion of the felt, and by forcing a string down the sides of the block, he causes the next part to assume the figure of the crown, which he continues to wet and work until it has properly disposed itself round the block. The rim now appears like a flounced or puckered appendage round the edge of the crown, but the block being set upright on the plank, the requisite figure is soon given by working, rubbing, and extending this part. Water only is used in this operation of fashioning or blocking, at the conclusion of which it is pressed out by the blunt edge of a copper implement for that purpose.

Previous to the dying, the nap of the hat is raised or loosened out with a wire brush, or carding instrument; the fibres being too rotten after the dying to bear this operation. The dying materials are logwood, and a mixture of the sulphates of iron and copper, known in the market by the names of green copperas and blue vitriol.

The dyed hats are, in the next place, taken to the stiffening-shop. One workman, assisted by a boy, does this part of the business. He has two vessels, or boilers, the one containing the grounds of strong beer, which costs seven shillings per barrel, and is used in this and other stages of the manufactory as the cheapest mucilage which can be procured; and the other vessel containing melted glue, a little thinner than it is used by carpenters. The beer grounds are applied in the inside of the crown to prevent the glue from coming through to the face, and also to give the requisite firmness at a less expense than could be produced by glue alone. If the glue were to pass through the hat in different places, it might be more difficult to produce an even gloss upon the face in the subsequent finishing. The glue stiffening is applied after the beer-grounds are dried, and then only upon the lower face of the flap, and the inside of the crown. For this purpose the hat is put into another hat, called a stiffening hat, the crown of which is notched, or slit open, in various directions. These are then placed in a hole in a deal board, which supports the flap, and the glue is applied with a brush.

The dry hat, after this operation, is very rigid, and its figure irregular. The last dressing is given by the application of moisture and heat, and the use of the brush and a hot iron, somewhat in the shape of that used by tailors, but shorter and broader on the face. The hat being softened by exposure to steam, is drawn upon a block, to which it is securely applied by the former method of forcing a string down from the crown to the commencement of the rim. The judgment of the workman is employed in moistening, brushing, and ironing the hat, in order to give and preserve the proper figure.

When the rim of the hat is not intended to be of an equal width throughout, it is cut by means of a wooden or metallic pattern. The contrivance is very simple and ingenious. A number of notches are made in one edge of a flat piece of wood for the purpose of inserting the point of a knife, and from one side or edge of this piece of wood there proceeds a straight handle,

which lies parallel to the notched side, forming an angle somewhat like a carpenter's square. When the legs of this angle are applied to the outside of the crown, and the board lies flat on the rim of the hat, the notched edge will lie nearly in the direction of the radius or line pointing to the centre of the hat. A knife being, therefore, inserted in one of the notches, it is easy to draw it round by leaning the tool against the crown, and it will cut the border very regular and true. This cut is made before the hat is quite finished, and is not carried entirely through, so that one of the last operations consists in tearing off the redundant part, which by that means leaves an edging of beaver round the external face of the flap. When the hat is completely finished, the crown is tied up in gauze paper, which is neatly ironed down. It is then ready for the subsequent operations of lining, &c.

Hats are also made for women's wear, of chips, straw, or cane, by platting, and sewing the plats together; beginning with the centre of the crown, and working round till the whole is finished. Hats for the same purpose are also wove and made of horse-hair, silk, &c. See Straw *hat*.

HATCHEL, or Hitchel, a tool with which flax and hemp are combed into fine hairs. It consists of long iron pins, or teeth, regularly set in a piece of board.

HATCHES, in a ship, a kind of trap-doors between the main-mast and fore-mast, through which all goods of bulk are let down into the hold.

Hatches also denote flood-gates set in a river, &c. to stop the current of the water; particularly certain dams or mounds made of rubbish, clay, or earth, to prevent the water that issues from the stream-works and tin-washes in Cornwall, from running into the fresh rivers.

HATCHWAY, the place where the hatches are. Thus, to lay a thing in the hatchway, is to put it so, that the hatches cannot be become at, or opened.

HATCHING, the maturating fecundated eggs, whether by the incubation and warmth of the parent bird, or by artificial heat, so as to produce young chickens alive.

The art of hatching chickens by means of ovens, has long been practised in Egypt; but it is there only known to the inhabitants of a single village named Berme, and to those that live at a small distance from it. Towards the beginning of autumn they scatter themselves all over the country, where each person among them is ready to undertake the management of an oven, each of which is of a different size, but in general they are capable of containing from forty to fourscore thousand eggs. The number of these ovens placed up and down the country is about three hundred and eighty-six, and they usually keep them working for about six months. As, therefore, each brood takes up in an oven, as under a hen, only twenty-one days, it is easy in every one of them to hatch eight different broods of chickens. Every Bermean is under the obligation of delivering to the person who intrusts him with an oven, only two-thirds of as many chickens as there have been eggs put under his care; and he is a gainer by this bargain, as more than two-thirds of the eggs usually produce chickens. In order to make a calculation of the number of chickens yearly so hatched in Egypt, it has been supposed that only two-thirds of the eggs are hatched, and that each brood consists of at least thirty thousand chickens; and thus it would appear that the ovens of Egypt give life yearly to at least ninety-two millions six hundred and forty thousand of these animals.

HATCHMENT, in heraldry, a name sometimes used for an achievement, or escutcheon over a gate, door, or on the side of an house.

Hatchment, also signifies the marshalling of several coats of arms in an escutcheon.

HAUL *the wind*, in naval affairs, to direct the ship's course nearer to that point of the compass from which the wind arises. *Example.* If a ship sail south-west, with the wind northerly, and it is necessary to haul the wind farther to the westward: to perform this operation, it is necessary to arrange the sails more obliquely with her keel; to brace the yards more forward, and to haul the lower sheets farther aft, and finally to put the helm over the larboard-side of the vessel. When her head is turned directly to the westward, and her sails are trimmed accordingly, she is said to have hauled the wind four points, that is to say, from south-west to west.

HAUTBOY, a musical instrument of the wind kind, shaped much like the flute, only that it spreads and widens towards the bottom, and is sounded through a reed. See Music.

HAW *finch*, in ornithology, the English name of a bird, known among authors by the name coccothraustes. See Aves, Plate VIII. fig. 6.

HAWKERS and PEDLARS, are such dealers or itinerary petty chapmen who travel to different fairs or towns with goods or wares, and are placed under the controul of commissioners, by whom they are licensed for that purpose, pursuant to Stat. 8 and 9 William III. c. 25, and 29 George III. c. 26. Traders in linen and woollen, sending goods to markets and fairs, and selling them by wholesale; manufacturers selling their own manufactures, and makers and sellers of English bone-lace going from house to house, &c. are excepted out of the acts, and not to be taken as hawkers.

HAWSER, in the sea-language, a large rope, or a kind of small cable, serving for various uses aboard a ship, as to fasten the main and fore shrouds, to warp a ship as she lies at anchor, and wind her up to it by a capstan, &c. The hawser of a man of war may serve for a cable to the sheet-anchor of a small ship.

HAWSES, in a ship, are two large holes under the bow, through which the cables run when she lies at anchor. Thus the hawse-pieces are the large pieces of timber in which these holes are made. Hawse-bags, are bags of canvass made tapering, and stuffed full of oakum; which are generally allowed small ships, to prevent the ship from washing in at these holes: and hawse-plugs, are plugs to stop the hawses, to prevent the water from washing into the manger.

There are also some terms in the sea-language that have an immediate relation to the hawses. As "a bold hawse," is when the holes are high above the water. "Fresh the hawse," or veer out more cable, is used when part of the cable that lies in the hawse is fretted or chafed, and it is ordered that more cable may be veered out, so that another part of it may rest in the hawses. "Fresh the hawse," that is, lay new pieces upon the cable in the hawses, to preserve it from fretting. "Burning in the hawse," is when the cables endure a violent stress. "Clearing the hawses," is disentangling two cables that come through different hawses. "To ride hawse-full," is when in stress of weather the ship falls with her head deep in the sea, so that the water runs in at the hawses.

HAZARD, a game on dice, without tables. It is played with only two dice; and as many may play at it as can stand round the largest round table.

Two things are chiefly to be observed, *viz.* main and chance; the latter belonging to the caster, and the former, or main, to the other gamesters. There can be no main thrown above nine, nor under five; so that five, six, seven, eight, and nine, are the only mains flung at hazard. Chances and nicks are from four to ten: thus four is a chance to nine, five to eight, six to seven, seven to six, eight to five; and nine and ten a chance to five, six, seven, and eight: in short, four, five, six, seven, eight, nine, and ten, are chances to any main, if any of these nick it not. Now nicks are either when the chance is the same with the main, as five and five, or the like; or six and twelve, seven and eleven, eight and twelve. Here observe, that twelve is out to nine, seven, and five; eleven is out to nine, eight, six, and five; and ames-ace and deuce-ace, are out to all mains whatever.

But to illustrate this game by a few examples: suppose the main to be seven, and the caster throws five, which is his chance; he then throws again, and if five turn up, he wins all the money set him; but if seven is thrown, he must pay as much money as there is on the board: again, if seven be the main, and the caster throws eleven, or a nick, he sweeps away all the money on the table; but if he throws a chance, as in the first case, he must throw again: lastly, if seven be the main, and the caster throws ames-ace, deuce-ace, or twelve, he is out; but if he throws from four to ten, he hath a chance; though they are accounted the worst chances on the dice, as seven is reputed the best and easiest main to be flung. Four and five are bad throws (the former of which being called by the tribe of nickers, little dick-fisher) as having only two chances, *viz.* trey-ace and two deuces, or trey-deuce and quatre-ace: whereas seven hath three chances, *viz.* cinque-deuce, five-ace, and quatre-trey. Nine and ten are in the like condition with four and five; having only two chances. Six and eight have indeed the same number of chances with seven, *viz.* three; but experienced gamesters nevertheless prefer the seven, by reason of the difficulty to throw the doublets, two quatres, or two treys. It is also the opinion of most, that at the first throw, the caster hath the worst of it. On the whole, hazard is certainly one of the most bewitching and ruinous games played on the dice. Happy, therefore, the man who either never heard of it, or who has resolution enough to leave it off in time. See CHANCES and GAMING.

HAZLE. See CORYLUS.

HEAD. See ANATOMY.

HEADBORROW, or HEADBOROUGH, the chief of the frank pledge, and he that had the principal government of them within his own pledge. He was called also burrowhead, bursholder, third-burrow, tithing-man, chief-pledge, or borrow-elder. He is now occasionally called a constable.

HEALTH, is a right disposition of the body, and of all its parts; consisting in a due temperature, a right conformation, just connection, and ready and free exercise of the several vital functions.

HEARING. See SOUND.

The organ of hearing is the ear, and particularly the auditory nerve and membrane. See ANATOMY and PHYSIOLOGY.

HEAT. The laws according to which the temperature of bodies is subject to increase or diminution, have been discussed in the articles CALORIC, CAPACITY, COLD, COMBUSTION, and CHEMISTRY. In the first of these articles, caloric was considered as a substance capable of passing from body to body, and subsisting in them in different states. This is the general doctrine of chemical philosophers: many of these, however, as well as others, incline to the hypothesis, that heat may consist in an undulatory or other intestine motion, either in the parts of bodies, or in some subtle fluid, or ETHER, which see. Among these, we may reckon Sir Isaac Newton, Mr. Cavendish, Dr. Young, and Count Rumford.

"If heat," says Dr. Young, "when attached to any substance, be supposed to consist in minute vibrations, and, when propagated from one body to another, to depend on the undulations of a medium highly elastic, its effects must strongly resemble those of sound, since every sounding body is in a state of vibration; and the air, or any other medium, which transmits sound, conveys its undulation to distant parts, by means of its elasticity: and we shall find, that the principal phenomena of heat may actually be illustrated by a comparison with those of sound. The excitation of heat and sound are not only similar, but often identical; as in the operations of friction and percussion: they are both communicated sometimes by contact, and sometimes by radiation; for, besides the common radiation of sound through the air, its effects are communicated by contact, when the end of a tuning-fork is placed on a table, or on the sounding-board of an instrument, which receives from the fork an impression that is afterwards propagated as a distinct sound. And the effect of radiant heat, in raising the temperature of a body, upon which it falls, resembles the sympathetic agitation of a string, when the sound of another string, which is in unison with it, is transmitted to it through the air. The water, which is dashed about by the vibrating extremities of a tuning-fork dipped into it, may represent the manner in which the particles at the surface of a liquid are thrown out of the reach of the force of cohesion, and converted into vapour; and the extrication of heat, in consequence of condensation, may be compared with the increase of sound produced by lightly touching a chord which is slowly vibrating, or revolving in such a manner as to emit little or no audible sound; while the diminution of heat by expansion, and the increase of the capacity of a substance for heat, may be attributed to the greater space afforded to each particle, allowing it to be equally agitated with a less perceptible effect on the neighbouring particles. In some cases, indeed, heat and sound not only resemble each other in their operations, but produce precisely the same effects; thus, an artificial magnet, the force of which is quickly destroyed by heat, is affected more slowly in a similar manner, when made to ring for a considerable time; and an electrical jar may be discharged, either by heating it, or by causing it to sound by the friction of the finger." See the articles first mentioned.

HEAT, *animal*. The temperature which animals, and even vegetables maintain during life, above that of surrounding objects, is a very striking phenomenon. By general analogies it has frequently been referred to the process of combustion; and from facts more distinctly pointed, the doctrine, that it depends upon the absorption of oxygen, has been advanced by modern chemists. But it is to Dr. Crawford we are indebted for a direct series of experiments, by which the nature of the process is directly made out. It would carry us too far into physiological disquisition, if we were to proceed to enquire respecting the nature of the parts, and the functions of organized beings. The blood which circulates through the lungs absorbs oxygen in the act of respiration, by means of which a portion of the carbon which it contains is acidified and carried off in the elastic state. After this, and perhaps other changes, the fluid passes through the arteries to the extreme vessels, depositing in some manner the elementary parts or principles of animal matter during the act of nutrition, in which state of still

further change the blood returns by the veins, and again passes through the course of circulation. From his experiments on the capacities of arterial and venous blood, Dr. Crawford found the capacity of the former for heat to be 1.030, and that of the latter only 0.892, whence he concludes, that though heat must be given out in consequence of the diminished capacity of the combined oxygen absorbed by respiration, yet the increased capacity of the arterial blood will prevent its becoming sensible immediately in the lungs; instead of which, it will be given out at the smaller ramifications where the blood becomes changed in its nature, and in its capacity for heat by its conversion to the venous state. It has also been established by the experiments of the same philosopher, that the process of absorption of oxygen is less in a higher than in a low temperature; the difference between the arterial and venous blood being at the same time less, and consequently the augmentation of temperature in the animal less considerable. This law of the animal economy, assisted by the increased evaporation, and by the slow conducting power of an animal body, and perhaps by the permanency of the enlarged capacity, seems sufficient to account for the power which animals possess of maintaining their natural temperature without any remarkable change in an atmosphere greatly heated, as was shewn in the experiments of Fordyce and Blagden. (See Philos. Trans. 1775.) It must be confessed, however, that some farther investigations seem wanting on this subject.

Though the lungs appear to be the great organ of oxygenation in the larger animals, it is well ascertained that a process of nearly the same nature is carried on at the skin; and in many of the smaller or less perfect animals there appears to be no other means for effecting this absorption.

HEATH. See Erica.

HEAVINESS, in general, the same with weight or gravity. See Gravity and Weight.

HEBENSTREITIA, in botany, a genus of the Didynamia Angiospermia class and order. Essential character: calyx emarginate, cleft underneath; corolla one-lipped, lip ascending, four-cleft; stamens inserted into the edge of the border of the corolla; capsule containing two seeds. There are six species, all natives of the Cape.

HECTIC. See Medicine.

HEDERA, in botany, English *ivy*, a genus of the Pentandria Monogynia class and order. Natural order of Hederaceæ. Caprifolia, Jussieu. Essential character: petals five, oblong; berry five-seeded, surrounded by the calyx. There are six species, with several varieties.

HEDERACEÆ, in botany, the name of the forty-sixth order of Linnæus's "Fragments of a Natural Method," consisting of the ivy, vine, and a few other genera, which from their general habit and appearance seem nearly allied. This order consists of herbaceous and shrubby plants, most of which, particularly the ivy and vine just mentioned, have creeping branches, that attach themselves by tendrils to the bodies in their neighbourhood. The roots are long; the stems and young branches commonly cylindric. The leaves are alternate, sometimes simple, as in the ivy and vine; sometimes winged, as in the zanthoxylum, or tooth-ach tree, in which the surface of the leaves is covered with points. On each side of the foot-stalk of the leaves of the vine are placed two pretty large stipulæ, or scales; from the side opposite to the leaves proceeds a branching tendril, which serves to fasten the plant to the bodies in its neighbourhood. The flowers are either hermaphrodite, as in the ivy and vine; male and female upon different roots, as in the ginseng; or hermaphrodite and male upon different roots, as in the zanthoxylum. The calyx, or proper flower cup, consists of one leaf divided into five parts, which are small, and generally permanent. The petals are commonly five; but in the cissus four, and in the zanthoxylum none. There are five stamina; but the cissus has only four. The anthers, or tops of the stamina, are roundish; in the ivy they are attached to the filaments by the sides. In the zanthoxylum the filaments are crowned with twin anthers. The seed bud is of different shapes; the seed-vessel is of the berry kind, with one, two, or five cells, and the seeds are from one to five in number, placed either in distinct cells, or, as in the case of the ivy and vine, dispersed through the pulp without any partition. See Panax, &c.

HEDGES, in agriculture, are either planted to make fences round inclosures, or to divide the several parts of a garden. When they are designed as outward fences, they are planted either with hawthorn, crabs, or blackthorn; but those hedges which are planted in gardens, either to surround wilderness-quarters, or to screen the other parts of a garden from sight, are

planted according to the fancy of the owner, some preferring ever-greens, in which case the holly is best; next the yew, then the laurel, laurustinus, phillyrea, &c. others prefer the beach, the hornbeam, and the elm.

HEDGE *hog*. See ERINACEUS.

HEDGE *sparrow*, the brown motacilla, white underneath, and with a grey spot behind the eyes. See MOTACILLA.

HEDWIGIA, in botany, so called from J. Hedwig, a genus of the Octandria Monogynia class and order. Essential character: calyx four-toothed; corolla four-cleft; style none; capsule tricoccous; seed a nut. There is only one species; *viz.* H. balsamifera, a lofty tree more than sixty feet in height, and nearly five feet in circumference, a native of St. Domingo. The wood is used for many purposes: the red gum that issues from the bark has a strong aromatic smell, and is serviceable in the cure of wounds: it is frequently called bois cochon.

HEDYCARYA, in botany, a genus of the Dioecia Icosandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: calyx eight or ten cleft; corolla none: male, filaments none; anthers in the bottom of the calyx, four-furrowed, bearded at the tip: female, germs pedicelled; nuts pedicelled, one-seeded. There is but one species; *viz.* H. dentata, a native of New Zealand.

HEDYCREA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx one-leafed, hemispherical, five-toothed; corolla none; drupe oval, one-celled; nut ovate, covered with fibres, one-celled; the shell hard. There is but one species; *viz.* H. incana, a native of Guiana, where it is called caligni by the natives, who are remarkably fond of the fruit, which is about the size of a large olive: the pulp is white, and of a sweetish taste; the shell is bony, and separates with difficulty from the fibres in the pulp; the kernel is two-lobed: it is but a small tree, not exceeding four feet in height.

HEDYOSMUM, in botany, a genus of the Monoecia Polyandria class and order. Essential character: male, ament covered with anthers; no perianth, corolla, or filaments: female, calyx three-toothed; corolla none; style one, three-cornered; berry three-cornered, one-seeded. There are two species, both natives of Jamaica.

HEDYOTIS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla monopetalous, funnel-shaped; capsule two-celled, many-seeded, inferior. There are eight species, natives of the East and West Indies, also of Cochin-china.

HEDYPNOIS, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx calycled, with short scales; seeds crowned with the calycle; outer without down, covered up in the scales of the calyx; inner having a down of five erectish awned chaffs: receptacle naked, hollow dotted. This genus, according to Professor Martyn, embraces some species of HYOSERIS and of CREPIS, which see.

HEDYSARUM, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: corolla keel transversely obtuse; legume jointed, with one seed in each joint. There are ninety species, only one of which is a native of Great Britain; *viz.* H. onobrychis, saintfoin, or cockshead, and but ten which are natives of Europe. Most of these are perennial. Linnæus relates a remarkable phenomenon belonging to H. gyrans, sensitive hedysarum, which is as follows: "This is a wonderful plant, on account of its voluntary motion, which is not occasioned by any touch, irritation, or movement in the air, as in the Mimosa, Oxalis, and Dionæa; nor is it so evanescent as in Amorpha. No sooner had the plants raised from seed acquired their ternate leaves, than they began to be in motion this way and that: this movement did not cease during the whole course of their vegetation, nor were they observant of any time, order, or direction; one leaflet frequently revolved, whilst the other on the same petiole was quiescent; sometimes a few leaflets only were in motion, then almost all of them would be in movement at once; the whole plant was very seldom agitated, and that only during the first year. It continued to move in the stove during the second year of its growth, and was not at rest even in winter."

HEEL, in the sea language. If a ship leans on one side, whether she be aground or afloat, then it is said she heels a-starboard, or a-port; or that she heels offwards, or to the shore; that is, inclines more to one side than to another.

HEEL *of the mast*, that part of the foot of any mast which is pared away slanting on the aftward side thereof, in order that it

may be stayed aftward on. The heels of the top-masts are squares.

HEGIRA, in chronology, a celebrated epocha among Mahometans. See CHRONOLOGY. The event which gave rise to this epocha was the flight of Mahomet from Mecca, with his new proselytes, to avoid the persecution of the Coraischites; who, being then most powerful in the city, could not bear that Mahomet should abolish idolatry, and establish his new religion. This flight happened in the fourteenth year after Mahomet had commenced prophet: he retired to Medina, which he made the place of his residence.

HEIGHT, in geometry, is a perpendicular let fall from the vertex, or top, of any right-lined figure, upon the base or side subtending it. It is likewise the perpendicular height of any object above the horizon; and is found several ways, by two staffs, a plain mirror, with the quadrant, theodolite, or some graduated instrument, &c. The measuring of heights or distances is of two kinds: when the place or object is accessible, as when you can approach to its bottom; or inaccessible, when it cannot be approached. See SURVEYING.

HEIR, in law, is he to whom lands, tenements, hereditaments, by the act of God and right of blood, descend of some estate of inheritance.

HEIR *apparent*. No person can be heir in fact until the death of his ancestor; yet he who stands nearest in degree of kindred to the ancestor, is called even in his lifetime, heir apparent.

And the law takes notice of an heir apparent, so far as to allow the father to bring an action of trespass for taking away his son and heir, the father being guardian by nature to his son, where any lands descended to him.

The heir, heir general, or heir at common law, is he who after his father's or ancestor's death has a right to all his land, tenements, and hereditaments; but he must be of the whole blood, not a bastard, alien, &c. None but the heir general, according to the course of the common law, can be heir to a warrantry, or sue an appeal of the death of his ancestor.

A custom in particular places varying the rules of descent at common law is good, such is the custom of gavel-kind, by which all the sons shall inherit, and make but one heir to their ancestor. The general custom of gavel-kind lands extends to sons only, but a special custom, that if one brother die without issue, all his brothers may inherit, is good.

To prevent injury to creditors by the alienation of the lands descended, &c. and depriving them of their claim on the lands, it is enacted by 3 and 4 William and Mary c. 14, that in all cases, where any heir at law shall be liable to pay the debt of his ancestor, in regard of any lands, tenements, or hereditaments descending to him, and shall sell, alien, and make over the same before any action brought or process sued out against him, such heir at law shall be answerable for such debt or debts in an action or actions of debt to the value of the said land so by him sold, alienated, or made over; in which case all creditors shall be preferred, in the same order as in actions against executors and administrators, and such execution shall be taken out upon any judgment or judgments so obtained against such heirs, to the value of the said land, as if the same were his own proper debts; saving that the lands, tenements, and hereditaments, *bona fide* aliened before the action brought shall not be liable to such execution. Provided, that where any action of debt upon any specialty, is brought against any heir, he may plead *riens per descent* at the time of the original writ brought, or the bill filed against him; and the plantiff in such action may reply, that he had lands, tenements, or hereditaments from his ancestor before the original writ brought, or the bill filed; and if upon issue joined thereupon, it be found for the plantiff, the jury shall inquire of the value of the lands, tenements, or hereditaments, so descended, and thereupon judgment shall be given, and execution shall be awarded as aforesaid; but if judgment be given against such heir, by confession of the action, confessing the assets descended, or upon demurrer, or *nihil dixit*, it shall be for the debt and damages, without any writ to enquire of the lands, tenements, or hereditaments so descended.

Before this statute, if the ancestor had devised away the lands, a creditor by specialty had no remedy, either against the heir or devisee. But by this statute it is enacted, that all wills and testaments, limitations, dispositions, or appointments, of or concerning any manors, messuages, lands, tenements, or hereditaments, or of any rent, profit, term, or charge out of the same, whereof any person at the time of his decease shall be seised in fee-simple, possession, reversion, or remainder, or have power

to dispose of the same by his last will and testament, shall be deemed and taken only against such creditor as aforesaid, his heirs, successors, executors, administrators, and assigns, and every of them, to be fraudulent, and clearly, absolutely, and utterly void, frustrate, and of none effect; any pretence colour, feigned or presumed consideration, or any other matter or thing to the contrary notwithstanding. And in those cases every such creditor may maintain his action of debt upon his said lands and specialties, against the heir at law of such obligor, and such devisee and devisees jointly, by virtue of this act; and such devisee and devisees shall be liable and chargeable for a false plea by him or them pleaded, in the same manner as any heir should have been for false plea by him pleaded, or for not confessing the lands or tenements to him descended. Provided, that where there hath been or shall be any limitation or appointment, devise, or disposition, of any manors, messuages, lands, tenements, or hereditaments, for the raising or payment of any real or just debt, or any portion, sum or sums of money, for any child or children of any person other than the heir at law, in pursuance of any marriage, contract, or agreement in writing, *bona fide* made before such marriage; the same and every of them shall be in full force, and the same manors, &c. may be holden and enjoyed by every such person, his heirs, executors, administrators, and assigns, for whom the said limitation, appointment, devise, or disposition was made, and by his trustee, his heirs, executors, administrators, and assigns, for such estate or interest as shall be so limited or appointed, devised or disposed, until such debt or debts, portion or portions, shall be raised, paid, and satisfied. And every devisee made liable by this act, shall be liable and chargeable in the same manner as the heir at law, by force of this act, notwithstanding the lands, tenements, and hereditaments to him or them devised, shall be aliened before the action brought. In the construction of this statute it has been held, that though a man is prevented from defeating his creditors by will, that yet any settlement or disposition he shall make in his life-time of his lands, whether voluntary or not, will be good against bond creditors; for that was not provided against by the statute, which only took care to secure such creditors from any imposition, which might be supposed in a man's last sickness; but if he gave away his estate in his life-time, this prevented the descent of so much to the heir, and consequently took away their remedy against him, who was only liable in respect of the lands descended; and as a bond is no lien whatsoever on the lands in the hands of the obligor, much less can it be so, when they are given away to a stranger.

HEIR *looms*, in law, are such goods and personal chattels, as, contrary to the nature of chattels, shall go by special custom to the heir, along with the inheritance, and not to the executor of the last proprietor.

HEISTERA, in botany, so called in honour of Laurence Heister, a genus of the Decandria Monogynia class and order. Natural order of Holoraceæ. Aurantia, Jussieu. Essential character: calyx five-cleft; petals five; drupe with a very large coloured calyx. There is but one species, *viz.* H. coccinea, a native of Martinico, in close woods near torrents. The French inhabitants call it bois perdrix, birds being very fond of the fruit.

HELENIUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. There are two species. These plants are natives of America, where they grow wild in great plenty, in the woods and other shady places, where the ground is moist.

HELIACAL, in astronomy, a term applied to the rising or setting of the stars, or, more strictly speaking, to their emersion out of and immersion into the rays and superior splendour of the sun. A star is said to rise heliacally, when after having been in conjunction with the sun, and on that account invisible, it comes to be at such a distance from him, as to be seen in the morning before sun-rising; the sun, by his apparent motion, receding from the star towards the east; on the contrary, the heliacal setting is when the sun approaches so near a star, as to hide it with his beams, which prevent the fainter light of the star from being perceived, so that the terms apparition and occultation would be more proper than rising and setting.

All the fixed stars in the zodiac, as also the superior planets, Mars, Jupiter, and Saturn, rise heliacally in the morning, a little before sun-rising, and a few days after they have set cosmically. Again, they set heliacally in the evening, a little before their achronycal setting. But the moon, whose motion eastward is always quicker than the apparent motion of the sun, rises

heliacally in the evening, after the new moon; and sets heliacally in the morning, when old and approaching to a conjunction with the sun.

The inferior planets, Venus and Mercury, which sometimes seem to go westward from the sun, and sometimes again have a quicker motion eastward, rise heliacally in the morning, when they are retrograde; but when direct in their motions they rise heliacally in the evening. The heliacal rising or setting of the moon, happens when she is seventeen degrees distant from the sun; but for the other planets, twenty degrees are required; and for the fixed stars, more or less according to their magnitude.

HELIANTHUS, in botany, *sun-flower*, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, somewhat squarrose; down two-leaved; receptacle chaffy, flat. There are twelve species. These are hardy herbaceous plants, most of them tall and large, all perennial excepting two, *viz.* H. annus and H. indicus. They are all natives of America.

HELICOID *parabola*, or *Parabolic Spiral*, is a curve arising from the supposition that the common parabola is bent or twisted, till the axis comes into the circumference of a circle, the ordinates still retaining their places and perpendicular positions with respect to the circle, all these still remaining in the same place.

HELICONIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Scitamineæ. Musæ, Jussieu. Essential character: spathes; perianth none; corolla three-petalled; nectary two-leaved; pericarpium tricoccous; seeds solitary. There are three species, natives of the West Indies and South America.

HELICTERES, in botany, a genus of the Gynandria Decandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: pentagynous; calyx one-leafed, oblique; petals five; nectary of five leaflets; capsule five-twisted. There are nine species, shrubs or trees, natives of both Indies, mostly tomentose; leaves alternate; peduncles axillary, few-flowered.

HELIOCARPUS, in botany, a genus of the Dodecandria Digynia class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: calyx four-leaved; corolla four-petalled; styles simple; capsule two-celled, compressed, longitudinally radiated on both sides. There is only one species, *viz.* H. americana, American heliocarpus. It is found growing wild about La Vera Cruz, in New Spain.

HELIOMETER, the name of an instrument for measuring with particular exactness the diameters of the heavenly bodies, and especially those of the sun and moon. This instrument is a kind of telescope, consisting of two object-glasses of equal focal distance, placed one of them by the side of the other, so that the same eye-glass serves for both. The tube of this instrument is of a conical form, larger at the upper end, which receives the two object-glasses, than at the lower, which is furnished with an eye-glass and micrometer. By the construction of this instrument two distinct images of an object are formed in the focus of the eye-glass, whose distance, depending on that of the two object-glasses from one another, may be measured with accuracy; nor is it necessary that the whole disc of the sun or moon should come within the field of view, since, if the images of only a small part of the disc be formed by each object-glass, the whole diameter may be easily computed by their position with respect to one another: for if the object be large, the images will approach, or perhaps lie even over one another, and the object-glasses being moveable, the two images may always be brought exactly to touch one another, and the diameter may be computed from the known distance of the centres of the two glasses. Besides, as this instrument has a common micrometer in the focus of the eye-glass, when the two images of the sun or moon are made in part to cover one another, that part which is common to both the images may be measured with great exactness, as being viewed upon a ground that is only one half less luminous than itself; whereas, in general, the heavenly bodies are viewed upon a dark ground, and on that account are imagined to be larger than they really are. By a small addition to this instrument, provided it be of a moderate length, M. Bouguer, the inventor, thought it very possible to measure angles of three or four degrees, which is of particular consequence in taking the distance of stars from the moon. With this instrument he found that the sun's vertical diameter, though somewhat diminished by the astronomical refraction, is longer than the horizontal diameter; and, in ascertaining this phenomenon, he also found, that the upper and lower edges of the sun's

disc are not so equally defined as the other parts; on this account his image appears somewhat extended in the vertical direction. This is owing to the decomposition of light, which is known to consist of rays differently refrangible in their passage through our atmosphere. Thus the blue and violet rays, which proceed from the upper part of the disc at the same time with those of other colours, are somewhat more refracted than the others, and therefore seem to us to have proceeded from a higher point; whereas, on the contrary, the red rays proceeding from the lower edge of the disc, being less refracted than the others, seem to proceed from a lower point; so that the vertical diameter is extended, or appears longer, than the horizontal diameter.

HELIOCENTRIC *latitude of a planet*, the inclination of a line drawn between the centre of the sun and the centre of a planet, to the plane of the ecliptic.

HELIOCENTRIC *place of a planet*, in astronomy, the place of the ecliptic wherein the planet would appear to a spectator placed at the centre of the sun.

HELIOPHILA, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ, Cruciformes. Cruciferæ, Jussieu. Essential character: nectaries two, bowed back towards the bladder of the calyx. There are ten species. These plants are all natives of the Cape of Good Hope.

HELIOSCOPE, in optics, a sort of telescope, peculiarly fitted for viewing the sun, without hurting the eyes. See TELESCOPE.

HELIOTROPE, in mineralogy, a species of the flint genus. It is of a green colour, and occurs massive, in angular and rolled pieces; it is commonly translucent on the edges; the specific gravity from 2.6 to 2.7. It is found in rocks, and is said to be the connecting link between jasper and chalcedony. In Asia, it is found in Bucharia, Persia, and Siberia; and in Europe, in Iceland and in Upper Saxony. From the beauty of the colour, and its great hardness, it is reckoned of great value among lapidaries, and that which has the greatest degree of translucency, and most numerous red spots, is of most value.

HELIOTROPIUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: corolla salver-shaped, five-cleft, with teeth interposed; throat closed with arches. There are twenty-four species, of which H. peruvianum, Peruvian turnsole, or Heliotrope, is a small shrubby plant, from two to three feet in height; the leaves are long, hairy, and much veined, of an ash-colour on their under side, on short foot-stalks; the flowers are produced at the ends of the branches, in short reflex spikes, growing in clusters; the peduncles divide into two or three, and these again into smaller ones, each sustaining a spikelet of pale blue flowers, which have a strong, sweet odour, somewhat resembling bitter almonds. It grows naturally in Peru; it flowers with us great part of the year, and those flowers which come out early in the summer, are succeeded by ripe seeds in autumn.

HELIX, in geometry, the same with SPIRAL, which see.

HELIX, in natural history, the *snail*, a genus of the Vermes Testacea class and order. Animal a limax; shell univalve, spiral, subdiaphanous, brittle; aperture contracted, semi-lunar or roundish. Of this genus more than three hundred species have been enumerated; they are separated into divisions; A. whorls, with a carinate acute margin; B. umbilicate, the whorls rounded; C. rounded imperforate; D. tapering; E. ovate, imperforate. Of the species, we shall notice H. cornea, the shell of which above is umbilicate, flat, blackish, with four round whorls. It is found in Europe, and on the coast of Coromandel, from a single line to an inch in diameter; shell chesnut, brown, rufous, whitish, yellowish, or blueish, polished and very fine striate transversely; whorls four or five, rarely turned contrary; the inhabitant is black, with dirty-grey tentacula, and produces a scarlet, but not very durable dye. H. formatia, a snail with five spires remarkably ventricose, slightly umbilicated, fasciated with a lighter and deeper brown: this is found in the woods of the southern counties of England; it is said to have been introduced into this country by Sir Kenelm Digby, for medical purposes. These are confined to the southern counties, attempts having been made, but without success, to bring them into Northamptonshire. This snail is used in many parts of Europe as food, particularly at Rome during the weeks of Lent: here they are fattened, and grow to a very large size. It is oviparous, very tenacious of life, and, towards winter, covers its aperture with a calcareous lid. H. hortensis,

garden-snail, shell imperforate, globular, pale, with broad interrupted brown bands: this species inhabits the garden and orchard in most parts of Europe; it abounds with a viscid slimy juice, which it readily gives out by boiling in milk and water, so as to render them thick and glutinous, and the compound, especially with milk, is reckoned efficacious in consumptive cases. Snails are very destructive to wall-fruit: lime and ashes sprinkled on the ground will keep them away, and destroy the young brood. Fruit, already bitten, should not be taken off the tree, for they will not touch the other, till they have wholly eaten this, if left for them. The eyes of snails are lodged in their horns, one at the end of each horn, which they can retract at pleasure. The manner of examining these eyes, which are four in number, is this: when the horns are out, cut off nimbly the extremity of one of them, and, placing it before the microscope, you may discover the black spot at the end to be really a semiglobular eye.

The dissection of this animal is very curious; for, by this means, the microscope not only discovers the heart beating, just against the round hole near the neck, which seems the place of respiration; but also the liver, spleen, stomach, and intestines, with the veins, arteries, mouth, and teeth, are plainly observable. The intestines of this creature are green, from its eating herbs, and are branched all over with fine capillary white veins; the mouth is like a hare's or rabbit's, with four or six needle-teeth, resembling those of leeches, and of a substance like horn. Snails are all hermaphrodites, having both sexes united in each individual; they lay their eggs with great care in the earth, and the young ones are hatched with shells completely formed. Cutting off a snail's head, a little stone appears, which is supposed to be a great diuretic, and good in all nephritic disorders: immediately under this stone, the heart is seen beating; and the auricles are evidently distinguishable, and are membranous, and of a white colour, as are also the vessels which proceed from them. So small an animal as the snail, is not free from the plague of supporting other smaller animals on its body; and, as in other animals, we find these secondary ones either living on their surface, as lice, &c. or only in the intestines, as worms; it is very remarkable, that the snail is infested in both these manners, lice being found sometimes on the surface of its body, and worms sometimes within its intestines. There is a part of the common garden snail, and of other of the like kinds, commonly called the collar; this surrounds the neck of the snail, and is considerably thick, and is the only part that is visible when the animal is retired quietly into its shell: in this state of the animal, these insects which infest it are usually seen in considerable numbers, marching about very nimbly on this part; besides, the snail, every time it has occasion to open its anus, gives them a place by which to enter into its intestines, and they often seize the opportunity.

HELLEBORUS, in botany, English *hellebore*, a genus of the Polyandria Polygynia class and order. Natural order of Multisilique. Ranunculaceæ, Jussieu. Essential character: calyx none; petals five, or more; nectary two-lipped, tubular; capsules many-seeded. There are seven species. The hellebores are all hardy, herbaceous perennials, with compound leaves, digitate, pedate, palmate, or ternate; the flowers have only a single cover; they grow either several together, at the ends of the stalk and its subdivisions, with a single bracte to each pedicle; or single on a scape, naked, or with a leaf for an involucre. They appear early in the spring, and often in the winter. The root of this plant is tuberous; at first it has no taste, but in a short time, a strong acridity becomes sensible to the mouth and throat. By distillation, an oil is obtained which is extremely poisonous: a one similar in its effects may be obtained from many plants.

HELM, in naval architecture, a long and flat piece of timber, or an assemblage of several pieces, suspended along the hind part of a ship's stern-post, where it turns upon hinges to the right or left, serving to direct the course of the vessel, as the tail of a fish guides the body. The helm is usually composed of three parts, *viz.* the rudder, the tiller, and the wheel, except in small vessels, where the wheel is unnecessary. As to the form of the rudder it becomes gradually broader in proportion to its distance from the top, or to its depth under the water. The back, or inner part of it, which joins to the stern post, is diminished into the form of a wedge throughout its whole length, so as that the rudder may be more easily turned from one side to the other, where it makes an obtuse angle with the keel. It is supported upon hinges, of which those that are bolted round the stern-post to the after extremity of the ship are

called googings, and are furnished with a large hole on the after-part of the stern-post. The other parts of the hinges, which are bolted to the back of the rudder, are called pintles, being strong cylindrical pins, which enter into the googings and rest upon them. The length and thickness of the rudder is nearly equal to that of the stern-post. The rudder is turned upon its hinges by means of a long bar of timber called the tiller, which is fixed horizontally in its upper end within the vessel. The movements of the tiller, to the right and left, accordingly direct the efforts of the rudder to the government of the ship's course as she advances; which, in the sea language, is called steering. The operations of the tiller are guided and assisted by a sort of tackle, communicating with the ship's side, called the tiller-rope, which is usually composed of untarred rope-yarns, for the purpose of traversing more readily through the blocks or pulleys. In order to facilitate the management of the helm, the tiller-rope, in all large vessels, is wound about a wheel which acts upon it with the powers of a crane or windlass.

There are several terms in the sea language relating to the helm; as, "bear up the helm;" that is, let the ship go more large before the wind: "helm a mid-ship," or "right the helm;" that is, keep it even with the middle of the ship: "port the helm," put it over the left side of the ship: "starboard the helm," put it on the right side of the ship.

HELMET, an ancient defensive armour worn by horsemen both in war and in tournaments. It covered both the head and face, only leaving an aperture in the front secured by bars, which was called the visor. It is still used in heraldry by way of crest over the shield or coat of arms, in order to express the different degrees of nobility by the different manner in which it is borne. Thus, a helmet in profile is given to gentlemen and esquires: to a knight, the helmet standing forward and the beaver a little open: the helmet in profile and open, with bars, belongs to all noblemen under the degree of a duke: and the helmet forward and open, with many bars, is assigned to kings, princes, and dukes.

There is generally but one helmet upon a shield; but sometimes there are two, and even three: if there be two, they ought to face each other; and if three, the middlemost should stand directly forward, and the other two on the sides facing towards it.

HELONIAS, in botany, a genus of the Hexandria Trigynia class and order. Natural order of Coronariæ. Junci, Jussieu. Essential character: calyx none; corolla six-petalled; capsule three-celled. There are two species, *viz.* H. bullata, spear-leaved helonias; and H. asphodeloides, grass-leaved helonias; both natives of North America.

HEMEROBIUS, in natural history, a genus of insects of the order Neuroptera. Mouth with a short horny mandible, the jaw cylindrical, straight, cleft; feelers four, unequal, filiform; wings deflected, not folded; antennæ setaceous, projecting, longer than the thorax which is convex. There are nearly forty species, in two divisions; A. lip cylindrical, membranaceous, annulate: B. lip horny, rounded at the tip, vaulted. The insects belonging to this genus are, like the ephemeræ, very short-lived, and in every state of their existence prey, with unceasing avidity, upon plant-lice. The larva is six-footed, generally ovate and hairy; the pupa mostly folliculate; the eggs are deposited in clusters on the leaves of plants, each placed on a small gummy pedicle. When touched many of them have an excrementious smell. The most common species is the H. perla, an insect of great beauty, seen chiefly in the middle, and towards the decline of summer; and is a slender-bodied fly, of a grass-green colour; with bright gold-coloured eyes; and four large, transparent, oval, wings, finely reticulated with pale-green veins. The eggs of this insect are supported on a delicate stem, of more than half an inch in length, which is attached to the surface of a leaf or twig. They may be seen most frequently on the lime-tree, and by some persons, unacquainted with their nature, they have been taken for a small species of the fungus. From the eggs are hatched the larva, which in a few days become fitted to undergo their change into the chrysalis state. For this purpose the animal draws a fine silk from the extremity of its body, and in a short space envelopes itself in a round ball, of the size of a small pea, affixed to a leaf or twig of the tree it frequents; and divesting itself of its skin commences a chrysalis; in about three weeks it becomes a complete insect. The hemerobius takes its name from the shortness of its life, as it seldom lives more than two or three days.

HEMEROCALLIS, in botany, English *day lily*, a genus of the Hexandria Mono-

gynia class and order. Natural order of Lilia, or Liliaceæ. Coronariæ, Linnæus. Narcissi, Jussieu. Essential character: corolla bell-shaped; the tube cylindric; stamina declining. There are five species.

HEMIMERIS, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-parted; corolla wheel-form; upper lip cloven, with a nectareous bag at the base. There are three species.

HEMIONITES, in botany, English *mule fern*, a genus of the Cryptogamia Filices, or Ferns. Generic character: capsules digested into lines, meeting together, either intersecting each other, or branched. There are eight species, natives of both Indies.

HEMISPHERE, in geometry, the half of a globe or sphere, when it is supposed to be cut through its centre in the plane of one of its great circles. Thus the equator divides the terrestrial globe into the northern and southern hemispheres: in the same manner the meridian divides the globe into the eastern and western hemispheres; and the horizon into two hemispheres, distinguished by the epithets upper and lower. See GLOBE and SPHERE.

The centre of gravity of an hemisphere is five-eighths of the radius distant from the vertex.

HEMISPHERE is also used to denote a projection of half the terrestrial globe, or half the celestial sphere, on a plane, and frequently called planisphere.

HEMISTICH, in poetry, denotes half a verse, or a verse not completed.

Of this there are frequent examples in Virgil's Æneid; but whether they were left unfinished by design or not is disputed among the learned; such are, "Ferro accincta vocat," Æn. II. v. 614. And "Italiam non sponte sequor," Æn. IV. v. 361.

HEMP. See CANNABIS.

The cannabis sativa, or hemp-plant, is cultivated on account of its external filaments, which constitute the hemp used for cordage, canvass, cloth, &c. and the seeds abound with oil. This plant is annual; it rises quick into a tall slender sort of shrub; its leaves growing by fives or sixes from the same pedicle, are a little jagged, and yield a strong smell which affects the head. The culture and management of hemp makes a considerable article in agriculture; requiring divers operations, as pulling, watering, beating, and swingling. It is sown in May, in a warm, sandy, rich soil; and is of itself sufficient to destroy weeds on any ground. The first season for pulling hemp is usually about the middle of August, when they begin to pull the male plants, called fimble hemp. But the safer method is to pull it a fortnight or three weeks later, when the male plants have fully shed their farina, without which the seeds will prove only empty husks. At the second pulling, a little after Michaelmas, the female plants, called karle hemp, are taken out of the ground. This karle hemp is laid in the sun to dry, and then housed, for the seed to be thrashed out. The female hemp alone produces seed to perpetuate the kind. The operations of harling, watering, breaking, swingling, and heckling hemp, are very much like those practised in the dressing of flax. The hemp imported into this country chiefly comes from Russia. Amongst it the Riga hemp deserves the preference, which according to the quality, is divided in rhyne, outshot, pass, and codilla hemp. The Italian, known in this country by the name of Bologna hemp, is of very prime quality, but comes too dear for the consumption of the northern parts of Europe. The best hemp should be clean, soft, tender, of long staple, and a sound palish-yellow colour, neither green nor red.

HEMIPTERA, half-winged, in natural history, the second order of insects, according to the Linnæan system. In this tribe the upper part of the wing-sheaths is of a tough or leathery texture; the lower part is membranaceous. Sometimes almost the whole wing-cover is leathery, but of a softer texture than the coleoptera. Grasshoppers, locusts, and the cicadæ, are contained in this division. The wing-covers in this order cross each other when closed, instead of meeting in a direct line. This order contains the following genera:

Aphis	Mantis
Blatta	Nepa
Chermes	Notonecta
Cicada	Papilio
Cimex	Phalæna
Coccus	Pneumora
Fulgora	Sphinx
Gryllus	Thrips
Macrocephalus	

HENDECAGON, in geometry, a figure that hath eleven sides, and as many angles.

HEPAR *sulphurus*, *liver of sulphur*, a combination of alkali and sulphur. See SULPHURET.

HEPATIC, in medicine and anatomy, any thing belonging to the liver.

HEPATIC *gas*, the old name for sulphuretted hydrogen.

HEPIALUS. See PHALENA.

HEPTACHORD, in the ancient poetry, signified verses that were sung or played on seven chords, that is, on seven different notes. In this sense it was applied to the lyre, when it had but seven strings. One of the intervals is also called an heptachord, as containing the same number of degrees between the extremes.

HEPTAGON, in geometry, a figure consisting of seven sides, and as many angles. In a regular heptagon, the angle at the centre is $= 51°\frac{3}{7}$; the angle of the polygon is $= 128°\frac{4}{7}$. The area is = the square of one of the sides multiplied by 3.6339, or if a equal the side, the area $= a^2 \times 3.634$ nearly $= a^2 \times \frac{7}{4} t$, where t is the tangent of $64°\frac{2}{7} =$ half the angle of the polygon.

In fortification, a place is termed an heptagon, that has seven bastions for its defence.

HEPTAGONAL *numbers*, in arithmetic, a sort of polygonal numbers, wherein the difference of the terms of the corresponding arithmetical progression is 5. Arithmeticals 1, 6, 11, 16, 21, &c., and these added together, make Heptagonals 1, 7, 18, 34, 55, &c. One of the properties of these numbers is, that if they be multiplied by 40, and 9 be added to the product, the sum will be a square number.

Thus
$$1 \times 40 + 9 = 49 = 7^2$$
$$7 \times 40 + 9 = 289 = 17^2$$
$$18 \times 40 + 9 = 329 = 27^2$$
$$34 \times 40 + 9 = 1369 = 37^2$$
$$55 \times 40 + 9 = 2209 = 47^2 \text{ \&c.}$$

Here it is evident, that the series of squares thus formed, is $7^2, 17^2, 27^2, 37^2, 47^2$, &c. the common difference of whose roots is 10, which is double the common difference of the arithmetical series from which the heptagonals are formed.

HEPTANDRIA, in botany, the seventh class in Linnæus's system, consisting of plants with hermaphrodite flowers, which have seven stamina or male organs. There are four orders of this class, derived from the number of styles.

HEPTARCHY, a government of seven persons: also a state or country divided into seven kingdoms, and governed by seven independent princes; in which sense it is particularly applied to the government of South Britain, when divided amongst the Saxons.

HERACLEUM, in botany, *cow parsnep*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: involucre caducous; corolla difform, inflex, emarginate; fruit elliptic, emarginate, compressed, striated, margined. There are six species, with several varieties.

HERALDRY. We shall commence this article with some account of the great and important services of the heralds in former times, how ancient heraldry hath been, their employments in war and peace, and in proclaiming and publishing weighty affairs.

As for their antiquity, they were in request among the ancient Greeks; Homer in his second book, speaks of nine heralds in the Grecian army; and with the Romans they were in such esteem, that Numa Pompilius, the second King of Rome, instituted a society of heralds, and Ancus Martius, his grandson, and fourth king of Rome, erected a college for them.

Their business was to determine peace and war, leagues, agreements, wrongs offered or taken by them or their enemies, and to execute martial messages, &c. and as the Romans strove chiefly to obtain honour, so the heralds distributed ornaments and rewards to all who performed worthy actions at home and abroad.

The Roman law strictly prohibited any to take up arms against an enemy, without the consent and approbation of these heralds, and one above the rest being called Pater Petratus, was crowned with vervain, from whence he became their chief, or king, either in denouncing war, or concluding peace, as now is practised in England.

In the time of Edward I. Thomas Earl of Lancaster, Leicester, and Derby, and constable of England, ordained, that no parson, curate, churchwarden, &c. should pull down any hatchment, coat of arms, or pennon, or eraze any tomb out of churches or church-yards; and also, that no goldsmith, coppersmith, glazier, painter, or marbler, have to do with arms, without the consent of the King of Arms of that province and that they should not set a merchant's mark within an escutcheon: which order was revived in 1707, by Henry Howard, earl of Bindon, deputy earl-marshal of England, with these additions, *viz.* that no engraver, chacer, carver, stone-cutter, coach-maker, funeral-undertaker, and others in the premises, should design, and appoint, to or for any persons, any arms, or ensigns armorial, &c. as they

would answer the contempt thereof at their peril.

The said Thomas Earl of Lancaster, also ordained, that (for the better observing of the aforesaid order) all the Kings of Arms should keep their chapters once every quarter of the year, at least, and that they should make their visitations in their provinces, or their marshals for them, every seventh year. And he likewise ordained, that the heralds, at the interment of every gentleman, (where they were called to that service) should take the pedigree, with diligent examination of old folks, and record the same.

The heralds, in former times, frequently attended their sovereigns in their wars abroad; and in their progress, were often dispatched to other princes, with messages of war, as defiances, &c. and if they received any violence or affront from those princes to whom they were sent, it was highly resented by him whom they served.

In the reign of King Edward III. Henry King of Castile sent an herald to the Black Prince, to know why he invaded his kingdom; and in 1415, King Henry V. of England, sending Antelope Pursuivant at Arms, from Southampton to the French King, to demand restitution of what he had detained wrongfully from him; the said King of France sent Montjoy King of Arms, from Roan, to assure King Henry he would give him battle.

The Emperor's herald defied Francis I. king of France; and giving his master all his titles, of Castile, Leon, Arragon, Naples, &c. in a long roll, King Francis commanded his heralds to receive the challenge, and to repeat Francis as many times as the other had kingdoms and petty titles.

At the baptism of Madame Isabelle de France, to whom King Henry VIII. of England was godfather, the infant's name was proclaimed by the king's and heralds of arms, both of France and England, having their coats of arms adorned with the arms of both kings.

In the year 1635, a French herald was sent from Paris to Flanders, where, by sound of trumpet, he denounced and proclaimed war against the King of Spain, and all his dominions, and fixed up and left the defiance in all the towns he passed.

Besides kings and princes, divers noblemen in ancient time had also their heralds and pursuivants, as in the reign of Richard II. anno 1379, the Earl of Northumberland sent an herald named Northumberland to that king, for a safe conduct to come and commune with him.

In 1436, the Duke of Gloucester sent his herald, named Pembroke, to defy the Duke of Burgundy; and the Duke of Bedford had his herald, named Bedford, whom he sent to defy Charles VII. of France.

In 1496, the thirteenth of Henry VII. the Earl of Surry sent Norroy king of arms, to the captain of Hayton-Castle, (which was one of the strongest places between Berwick and Edinburgh) to deliver him the said castle, which he refused; and whilst the said Earl lay at Hayton, the King of Scotland sent to him Marchmont, and another herald, with a challenge, either to fight army to army, or person to person.

Heralds have likewise been employed in justs and tournaments; and as to shields and arms, we read that King Henry III. in the twenty-eighth of his reign, anno 1244, commanded the keepers of the Archbishoprick of Canterbury, that they caused to be brought a fair stone, to be laid upon the body of Gerald Fitz-Maurice, who was justice of Ireland, and died at Canterbury, and also commanded them to set thereon his shield with his arms. And thus much may suffice to show the antiquity of heralds, and in some measure their use; next of their college.

Of the College of Heralds. This college is seated upon St. Bennet's Hill, near Doctor's Commons, and was the ancient house of Thomas Stanley, Earl of Derby, who married Margaret Countess of Richmond, mother of Henry VII.; and the Duke of Norfolk, having in lieu thereof exchanged lands with the crown, he procured the same to be bestowed by Queen Mary on the King's heralds and pursuivants of arms for ever; to the end that they might reside together, (if they pleased) and assemble and agree together, for the good government of their faculty, and that their records might be there safely preserved, &c.

Since the fire of London, 1666, which consumed the whole house, it is fairly and conveniently rebuilt, with a large room for the keeping the Court of Honour, together with a library and houses and apartments for the officers thereto belonging.

They were made a college or corporation by charter of King Richard III. and by him (being wholly employed and entrusted in regulating all affairs belonging to the noble science of arms) had several privileges granted them, as to be free from subsidies, tolls, and all manner of offices in the

kingdom; all which privileges were confirmed by King Edward VI. in the third of his reign; and for their regular proceedings have a public signet, wherewith they seal and authorise all business concerted in the office.

Of this collegiate society are (besides the Earl Marshal, who is their head) three kings of arms, six heralds, and four pursuivants; of all which, we will speak in their order.

Of the Earl Marshal. This great office, which is hereditary in the noble family of Howard, Dukes of Norfolk, (descended by the mother's side from Thomas de Mowbray, Earl of Nottingham, the first Earl Marshal of England) which office is now held by his Grace Charles Duke of Norfolk; and by the statute of 31 Henry VIII. has his place next after the Lord Great Chamberlain, and Constable, and before the Lord High Admiral, and Lord Steward of the King's house.

This officer, who is governor of the college of heralds, has sometimes been the King's lieutenant general in martial affairs, and is an Earl by his office, which no other officer in England is.

The Earl Marshal's court was held in the college of heralds, wherein he took cognizance of all matters of war and arms, being commonly guided by the civil law.

He determines all questions and differences that may arise between the heralds and other persons, concerning pedigrees, honour, arms, crest, supporters, and ensigns armorial; and he, or his deputy, being judge and head of the college, has power of making rules, ordinances, and decrees, for regulating thereof.

As in the college of heralds, the arms of all the families and names in England are (or ought to be) recorded, together with the time when their arms were granted, and upon what occasion; and as in the said office every man's fame and dignity is preserved, so his Lordship hath power by special commission, under the great seal of England, of prohibiting the provincial kings (which are Clarencieux and Norroy) to give and grant any new arms without his Lordship's consent; and when any such are usurped, and unjustly borne, he has power to examine and disclaim the same, and to punish the parties that shall falsely assume the arms of another.

He bears a staff of gold tipped with black, having the king's arms enamelled on one end, and his own at the other, and takes his place with the Lord Great Chamberlain, or the Constable, next before the sword.

At a coronation the Earl Marshal has the ordering of the Abbey of Westminster, and sees the regalities and robes of King Edward the Confessor to be in a readiness, where the solemnity is held.

He appoints the building of the throne whereon the King or Queen is to be crowned, and gives orders to the gentlemen-ushers, for the covering and furnishing thereof with hangings, chairs, carpets, cushions, &c.

At such time the Earl Marshal is one of those that does all the nearest offices to the King's person, as to help to lead him, and to support his Majesty in his chair, putting his hand, with others of the nobility, to set the crown on his head, doing his homage first, and then presenting the nobility in their several degrees, being all vested in their robes of estate, wearing their coronets when they do their homage.

At the creation of any great estate, as Duke, Marquis, or Earl, the Earl Marshal has the furniture of the said estate, or a composition for it, as also by ancient custom he has had the like of archbishops, bishops, and abbots, at their consecrations.

At the funeral obsequies of kings, queens, and princes, the Earl Marshal is a chief commissioner appointed with the Lord Treasurer, the Lord Great Chamberlain, and others of the Lords of the King's Council, to give orders to the wardrobe, for the distribution of black for mourners, for the furnishing the hearse with velvets, palls of cloth of gold, escutcheons, banners, and hatchments, giving charge to the officers of arms to give their attendance, and to see all things royally and princely performed.

Assisted by the kings and heralds, he marshals and orders the proclamation and coronation of our kings, their marriages, christenings, funerals, cavalcades, royal interviews, feasts, &c.; and also when war or peace is proclaimed; so that he keeps a court of chivalry in the common hall of the college of heralds, where they sit as his council and assistants, in their rich coats of his Majesty's arms, being all the King's servants in ordinary: and besides these, there are six proctors, who are to plead all causes relating to coats of arms, that are tried before the Earl Marshal, or his deputy, in the college of heralds.

The manner of admitting officers into the College of Arms is as follows:

At their first entry, they are commended to the Sovereign by a bill signed by the

Earl Marshal's hand; which done, the King signs the same, and so it passes the privy seal and broad seal; and that once obtained, they are to be sworn and created by the Earl Marshal, or his deputy.

Of the Kings of Arms. 1. Garter principal King of Arms of Englishmen, and chief officer of arms of the most noble order of the Garter. 2. Clarencieux King of Arms. 3. Norroy King of Arms.

Garter. This officer was constituted by King Henry V. with the advice and consent of the Knights of the Garter, for the service of the said most noble society, and from thence took his name; and his Majesty, for the greater dignity of the order, being pleased to annex thereto the office of principal King of Arms, from hence he is honoured with two distinct titles, *Garter*, and principal King of Arms.

The duty of his office, in relation to the Garter, is in general, to perform whatever the Sovereign, prelate, or chancellor of the said order, shall enjoin him relating thereto; such as carrying the rod and sceptre at every feast of St. George, when the Sovereign is present, to notify the election of such Knights as are newly elected, to call upon them to be installed at Windsor, to attend the solemnity at their installation, to cause their arms to be put over their seats in the chapel there, to marshal the funeral rights and ceremonies of those knights, to carry the Garter to foreign kings and princes, that are chosen to be knights of that most noble order, to take cognizance of the arms of the nobility, and to make supporters to those created to any new degree of peerage; for which he has allowed him a salary and fees, both from the Sovereign and the knights.

This officer, as principal Herald or King of Arms in England (as Lion is in Scotland, and Ulster in Ireland) marshals the solemn funerals of the higher nobility of England, as Princes, Dukes, Marquisses, Earls, Viscounts, and Barons, as also does many other services to the King and State; and therefore, as the other Kings have, has a salary out of the Exchequer, and double their fees at the instalments of the Knights of the Garter, and a composition for the uppermost garment of each knight at his installation.

It may not be improper to notice the peculiar bearings or attributes of the greatest antiquity before we proceed to treat of more modern facts. The Heathen divinities had each their distinctive mark; Jupiter wielded the lightning in his right hand; Neptune bore the three pronged trident; Mars the spear; Saturn the scythe; and Bacchus the spear, encircled by ivy; the Phrygians, the sow; the Goths, a bear; the Thracians, Mars; the ancient French, the lion, which was afterwards changed to the toad, and that again for the fleur de lis, sent them from Heaven by an angel, whose commission was directed to Clovis, their first Christian monarch; the Saxons, a horse; the Flemings, a bull; the King of Antioch, an eagle grasping a dragon; the Romans, the eagle; Pompey, a lion holding a sword; yet the Roman people, who were saved by the cackling of geese, despised that bird in too great a degree to admit it into their ensigns: exclusive of the above, there were many nations and individuals who distinguished themselves by exhibiting every description of weapons on their banners. It should also be observed, that the most ferocious beasts and birds were selected as emblematic of honour and courage, for this reason, shields, with their figures only, are considered as most honourable and ancient; but those with trees, flowers, plants, the sun, moon, planets, varieties of colours, or charged with any of the honourable ordinaries, or artificial objects, are deemed of less importance.

The science of heraldry consists principally of blazoning and marshalling; the former is the art of displaying a coat of arms in its proper colours, the latter is the combining various arms in one shield. In blazoning it is usual to begin with the field, and then proceed with the charge, and in naming the objects charged in the field, to mention the most predominant, and next the field, first; and then the most remote. Gwillim observes, that tincture is a variable hue of arms, and as applicable to differences as to the arms, and is distributed into colours and furs. The same author considers colours an external dye, or the gloss of any illuminated object, and the colour alluded to is considered general and special. The general implies the natural colour of bodies, whether artificial or otherwise; those borne in their natural colours must be blazoned proper, without mentioning the colours.

There are forms in heraldry which have names only applied to them, and no colour specified in the blazoning, the term sufficiently explaining the colour of each; they resemble a globe or ball, and are called besants the colour or plates argent; hurts, azure; torteauxes, gules; pel-

lets or ogresses, sable; pomeis, vert; golpes, purpure; oranges, tenue, and grosses, sanguine. In these nine varieties are included all the colours generally used in blazonry.

The blazoning of the arms of gentlemen, esquires, knights, and baronets, is derived from metals and colours; those of barons, viscounts, earls, marquisses, and dukes, from precious stones; and those of princes, kings, and emperors from the planets. See Colours.

Or, gold, is expressed by dots (see Plate of I. Heraldry, fig. 1) and is intended as an intimation that as gold surpasses all other metals in value and purity, he that bears it should endeavour to excel in the same proportion, the same insinuation is implied in the topaz and the sun.

Argent, or white, is represented by a perfect blank (see fig. 2), this colour ranks next to Or, and without gold and silver Heraldry would be imperfect, argent signifies innocence, temperance and hope, the pearl was supposed by the antients to possess a restorative property, and Luna is acknowledged to be the mistress of honour, the seas and tides.

Gules, red, is expressed by perpendicular lines, or lines paleways from the chief to the base (see fig. 3), this colour has ever been considered as symbolical of majesty and dignity; the ruby cannot be wasted by fire or water, and Mars, the planet, alludes to the heathen God of battle, the patron of courage and military address.

Azure, blue, the lines in this instance are horizontal (see fig. 4) and intended for the tint of the air or sky, and is said to denote loyalty, fidelity, and chastity; the precious stone and planet in azure were adopted as possessed of superior qualities, emblematic of the worth of nobles and princes.

Sable, or black, represented by perpendicular and horizontal lines crossing each other at right angles (see fig. 5). Sable indicates gravity, constancy, and grief for the loss of friends; the diamond is the most valuable of all stones, and Saturn presides over counsellors and other grave characters.

Vert, green, the lines are bendways (see fig. 6) or from the sinister corner of the chief to the opposite of the base, and is emblematical of youth, peace, and concord.

Purpure, is a colour composed of a large part of crimson, and a less of blue, and the lines which express it tend directly contrary to those of vert, (see fig. 7) this word is derived from the fish called purpura; the amethyst was preferred for its excellence to decorate the breast of Aaron, and the planet Mercury signifies goodness of temper.

Tenne, or tawny, is a mixture of red and yellow, and represented by lines like those of purpure, it has been but little used in England, but was formerly in a considerable degree in France.

Sanguine, is composed of lake and a small quantity of Spanish brown, and expressed by lines as purpure, it was much used by the knights of the Bath, and by the serjeants at law in their vestments; the Sardonix is said by St. John to be the sixth stone in the Heavenly Jerusalem.

Furs are the next object to be considered, the use of which may be thus explained.

Ermine, implies a field argent, with the powdering sable, (see fig. 8.)

Ermines, is the reverse, or a field sable, and the powderings argent.

Erminois signifies a field or, and the powdering sable.

Pean, is a field sable, and the powderings or.

Vair, is of two descriptions, if it consists of argent and azure it is sufficient to say vair, but if it is compounded of any other colours, it is usual to say vairy of the colours adopted. (see fig. 9.)

Fig. 10 is blazoned potent-counter-potent, and the colours argent and azure.

Doublings, or furs, were antiently, and are at present used for the linings of the robes and mantles of senators, consuls and kings.

The bordure is extended to a great variety, as (fig. 11) gules a bordure, or; (fig. 12), a bordure indented, argent; (fig. 13) a bordure counter compone, argent and gules.

The bordure is generally one-sixth part of the breadth of the shield, and is ingrailed, indented, charged, componed and countered. If the inner line of the bordure is strait and the latter plain, the colour of the bordure alone is named in blazoning; if it is charged with parts of plants or flowers, it is described as verdoy of trefoils. If it consists of ermines, Vair or vairy, or any of the furs, the heralds say purflew of ermines. When charged with martlets, charged with an enaluron of martlets.

The label is the first of the distinctive marks of the branches of a family, and is borne by the eldest son during the life of his father (see fig. 14). The second son bears a crescent, the third a mullet,

the fourth a martlet, the fifth an annulet, the sixth a fleur de lis, the seventh a rose, the eighth a cross moline, and the ninth a double quatrefoil, (see figures 15, 16, 17, 18, 19, 20, 21, 22.)

Those differences should be strictly observed by every brother or house, to prevent contention relating to coat armour.

In the second house, the first son bears a crescent charged with a label during his father's life only; the second son, of the same house, a crescent charged with another crescent; the third, a crescent charged with a mullet; the fourth, a crescent charged with a martlet; the fifth, a crescent charged with an annulet; and the sixth, a crescent charged with a fleur de lis.

The mullet, which is the difference of the third house, is thus charged: the first son, with a label during the life of his father; the second, with a crescent; the third, with a mullet; the fourth, with a martlet; the fifth, with an annulet; and the sixth, a fleur de lis.

The martlet, annulet, and fleur de lis, the differences of the fourth, fifth and sixth houses, are charged for distinctions similar to the mullet.

The daughters of families are permitted to bear their fathers arms, with the same distinctions used by them.

The shield, or escocheon, the mantle, the helmet and crest, are the several parts of arms which compose an achievement. Accidents in the escocheon, are points and abatements; the former are places in the shield named according to their position in the middle, or remote, the middle are near the centre. The fess point is the centre of the escocheon. The honour point is in a direct line above it, and the nombril is next below it. Remote points are placed at still greater distances from the fess point, some of which are superior and others inferior; the former occupy the upper part of the escocheon, and of those there are middle and extremes, the middle is the exact middle of the chief between the two extremes; the two superior extreme points occupy the corners of the chief part of the escocheon, and are termed the dexter and sinister. The inferior points are at the base, and of them there are middle and remote, (see fig. 23) in which A is the dexter chief point; B, the precise middle chief; C, the sinister chief; D, the honour point; E, the fess point; F, the nombril point; G, the dexter base; H, the dexter middle base; I, the sinister base point. An abatement is a casual mark annexed to coat armour, which announces some dishonourable act of the bearer. Abatements consist of diminution and reversing, the first is the blemishing of some particular point of the escocheon by sanguine and tenne, which are stains; were the metals used they would be considered additions of honour. See fig. 24.

Augmentations are additional charges borne on an escocheon, a canton, or chief, and given as particular marks of honour. See fig. 26.

Escocheons are either of one or more tinctures: of those of more than one, that is said to be predominant, when some one metal-colour or fur is supposed to be spread over the whole surface of the escocheon, which is termed the field, or shield: in such as have more than one tincture, the field and charge must be observed.

The charge is that which possesses the field, whether natural, artificial, vegetable, or sensitive, and may be placed throughout the superfices, or in some particular part of the escocheon.

Ordinaries consist of lines variously drawn. The properties of them depend upon their deviations from a right line. Those are termed engrailed, invected, waved, crenelle, or embattled, nebule, indented, and dancette. (See fig. 27.) Of these, and straight lines, honourable ordinaries, abatements, and rewards of honour are composed.

The honourable ordinaries are the cross, chief, fess, barr, pale, chevron, bend, saltier, and escocheon.

The cross occupies the fifth part of the escocheon; if charged, the third; and is borne engrailed, invected, wavey, &c. between a charge, and charged as the rest of the ordinaries are. (See fig. 28.) Argent a cross sable.

The chief is peculiar to those who have obtained it by extraordinary merit: it contains one third part of the escocheon in depth, and is divided into a fillet, which includes a fourth part of the chief, and is placed in the chief point. (See fig. 29.) Or, a chief gules.

The fess is situated in the centre of the shield, and contains in breadth the third part of the escocheon. (See fig. 30. Azure a fess, or.) The bar differs from the fess only, as it is but the fifth part of the shield. It is divided into the closet, or a moiety of the bar; and the barulet, or half the closet.

The pale contains the third part of the

escocheon, and is divided into a pallet, or one half of the pale. An endorse is the fourth part of a pale, and is not used but when the pale is between two of them. If the pale is upon an animal, it is usual to say, he is debrused with the pale, if the beast is on the pale, he is supported of the pale. (See fig. 31.) Gules, a pale, or.

The chevron resembles the rafters of a house, and occupies the fifth part of the field, and is divided into the chevronel, which contains half the chevron; and a couple close, the fourth part of the chevron. Those are not borne but in pairs, unless there is a chevron between them. (See fig. 32.) Gules, a chevron argent.

The bend contains the fifth part of the field in breadth when not charged; when charged, the third; and is divided into the bendlet, which is limited to the sixth part of the shield; into a garter, the moiety of a bend; into a cost, the fourth part of a bend; and a riband, the half of a cost. (See fig. 33.) Or, a bend azure.

There is, besides, the bend sinister, which passes obliquely across the escocheon, from the sinister chief to the dexter base. This is divided into the scrape, half the bend; and the battune, the fourth part of the bend, the most common badge of illegitimacy. (See fig. 34.) Gules, a battune argent.

The saltire contains the fifth part of the shield; if charged, the third. This object represents an ancient description of scaling ladder; and, similar to the other ordinaries, is borne engrailed, wavy, &c. &c. (See fig. 35.) Sable, a saltire embattled, counter embattled, argent.

An inescocheon consists of the fifth part of the field, and is to be placed in the fess point. Those who marry an heiress bear her arms on an escocheon of pretence. (See fig. 36.) Ermine, an inescocheon gules.

The pile is an ordinary, in form like a wedge; is an ancient addition to armoury, and adopted from the pointed instrument used to secure foundations on marshy grounds. (See fig. 37.) Azure, a pile ermine.

Partitions are such in which there is no tincture from metal, colour, or fur predominating in them, and are formed of various lines of partition, often causing counterchanging and transmutation. This kind of bearing may be engrailed, &c. (See fig. 38. Plate II.) Parted per pale, argent and gules.

An example of counterchanges is given in fig. 39. Or, a cross per pale, gules and sable.

Another of ordinaries joined is shewn in fig. 40. Gules on a chevron argent, three bars, gemells sable.

The artificial objects used in heraldry are very numerous, and far too much so for enumeration: they express ensigns of dignity, both spiritual and temporal, the liberal and mechanical professions, and military and naval acts. See fig. 41.

Military figures are equally usual, and consist of castles, battering rams, daggers, spears, &c. &c.

Common charges are composed of objects natural or artificial; celestial are borne single, upon or between any of the honourable ordinaries, and then three are the usual number. (See fig. 42.) Diamond, a fess ermine, between three crescents topaz.

Under the article of vegetables are included trees, plants, leaves, flowers, and fruits. An illustration is given in fig. 43. Vert, five fig-leaves in saltier.

Various parts of the human body and the blood are borne in heraldry. (See fig. 44.) Argent, goutte de sang. Those are, however, seldom borne alone, but upon or with some of the ordinaries. Goutte de sang only, always signifies gules; goutte de larmes, drops of tears, azure; goutte de eau, drops of water, argent; de poix, or sable, drops of pitch and d'or. The form of each is the same. The bloody hand is the appropriate mark of a baronet.

Of the various animals used, the lion is the most honourable; and all quadrupeds are considered more so than the bearings of fishes or fowls, particularly the males. The lion is borne rampant, (see fig. 45.) argent, a lion rampant sable; and passant, (see fig. 46) or, a lion passant sable, in chief three piles of the second. Parts of the lion are also generally adopted (see fig. 47.) Argent, a lion's head erazed vert. The varieties of beasts and their parts are extremely common, and cannot possibly be specified in an article so brief as the present, (see fig. 48.) Gules, a talbot passant, or, a chief ermine. All animals which are quadrupeds, and oviparous, may be borne. (See fig. 49.) Azure a tortoise erect, or. Fowls of every description are to be represented in the natural acts of standing or flying: those that are either whole footed, or have their feet divided, and have no talons, should be termed membered; the cock, and all birds of prey, must be called armed, and the arming or membering of them is to be of a different colour from the fowl or

bird: in the blazoning of fowls which make much use of their wings, if they are not exhibited spread, they must be termed close. The parts and members are generally borne both couped and erazed, and that on or between any of the honourable ordinaries. Birds are considered a more noble bearing than fish. (See fig. 50.) Ermine, an eagle displayed gules.

Fishes are borne in many positions, directly upright, embowed, extended, and indorsed, and surmounting each other, fretted and triangle. (See fig. 51.) Azure, three trouts fretted in triangle argent. Those upright, with fins, were anciently termed in blazoning hauriant, signifying the act of respiration, to accomplish which fish frequently rise to the surface for fresh air; when borne transverse, or swimming, they were called in blazoning naiant. Fishes are borne in part, and on or between any of the honourable ordinaries.

There are, besides, animals or monsters, (see fig. 52.) Argent, a dragon's head erazed vert, holding in his mouth a sinister hand, couped at the wrist, gules.

Such are the peculiarities which distinguish the shield within the boundaries of its surface, we shall now proceed to treat of the helmet, and shew how it is placed in various cases, on the shield, above the coronet, and in others without the latter symbol of rank which equally marks the gradation of title with the helmet. The crown or coronet is more ancient than the helmet, and was invented as a testimony of triumph and victory; the radiated crown was assigned to Emperors; but the coronet with pearls on the circle, and foliage intervening, was not used in heraldry more than 300 years past. (See fig. 53—56) the coronet of a Duke, Marquis, Earl, Viscount, and Baron; besides ducal, mural, naval, civic, celestial, custom, valary, &c.

The helmet was worn in battle and at tournaments, both for use and distinction. Since the invention of fire arms it has been nearly confined to heraldic purposes. The manner of placing them on shields is shewn with in figs. 57, 58, 59. Those right in front, many bars, to Sovereigns; those nearly in profile to Peers; when front and open, to Baronets and Knights; in profile close, to Esquires and Gentlemen.

The wreath is a roll of silk, of two colours blazoned on the shield, and laid on the helmet as a support to the crest. See fig. 60.

The crest is the most elevated part of the armour of the head, and is said to be derived from *crista*, or cocks-comb. The original use appears to have been a protection from the edge of the sword, when aimed at the upper part of the skull. Gwillim asserts, that the crest, or cognizance, should possess the highest place next to the mantle, yet so as to permit the interposition of a scroll, wreath, chapeau, or crown. The knights who celebrated justs wore plumes, of the heron and ostrich feathers, with crests of various materials, which were altered at pleasure. They are of great antiquity, and were of superior honour, as no person was admitted to tilt at a just till he had given proof of his noble descent, and they were limited to those only, (See fig. 61) which exhibits a crest on the wreath.

The mantle is the drapery that is thrown around a coat of arms: it is doubled, or lined throughout by one of the furs.

Supporters are figures by the side of a shield, appearing as if they actually held it erect. (fig. 62.) In England supporters are confined to Peers, and Knights of the four orders and proxies of the Princes of the Blood Royal, at installations, except by an especial grant from the Sovereign.

Heralds. The heralds, which are six in number, are distinguished by the names of Richmond, Lancaster, Chester, Windsor, Somerset, and York, and are all equal in degree, only preceding according to the seniority of their creation, their patents being under the great seal of England.

HERB, in botany, is that part of the plant which rises from the root, and is terminated by the fructification. It comprehends the trunk and stem; the leaves; the fulcra, or supports; and the buds, or, as they are sometimes denominated, the winter quarters of the future vegetable.

Herbaceous *plants*, in botany, are those which have succulent stems that die down to the ground every year; those are annual that perish stem and root every year; biennial, which subsist by the roots two years; perennial, which are perpetuated by their roots for a series of years, a new stem being produced every spring.

HERCULES, in astronomy, a constellation of the northern hemisphere. See Astronomy.

HEREDITAMENTS, all such things immoveable, whether corporeal or incorporeal, as a man may leave to him and his heirs, by way of inheritance; or which not being otherwise devised, naturally descend

HERALDRY.

Plate II.

NELSON AND BRONTE

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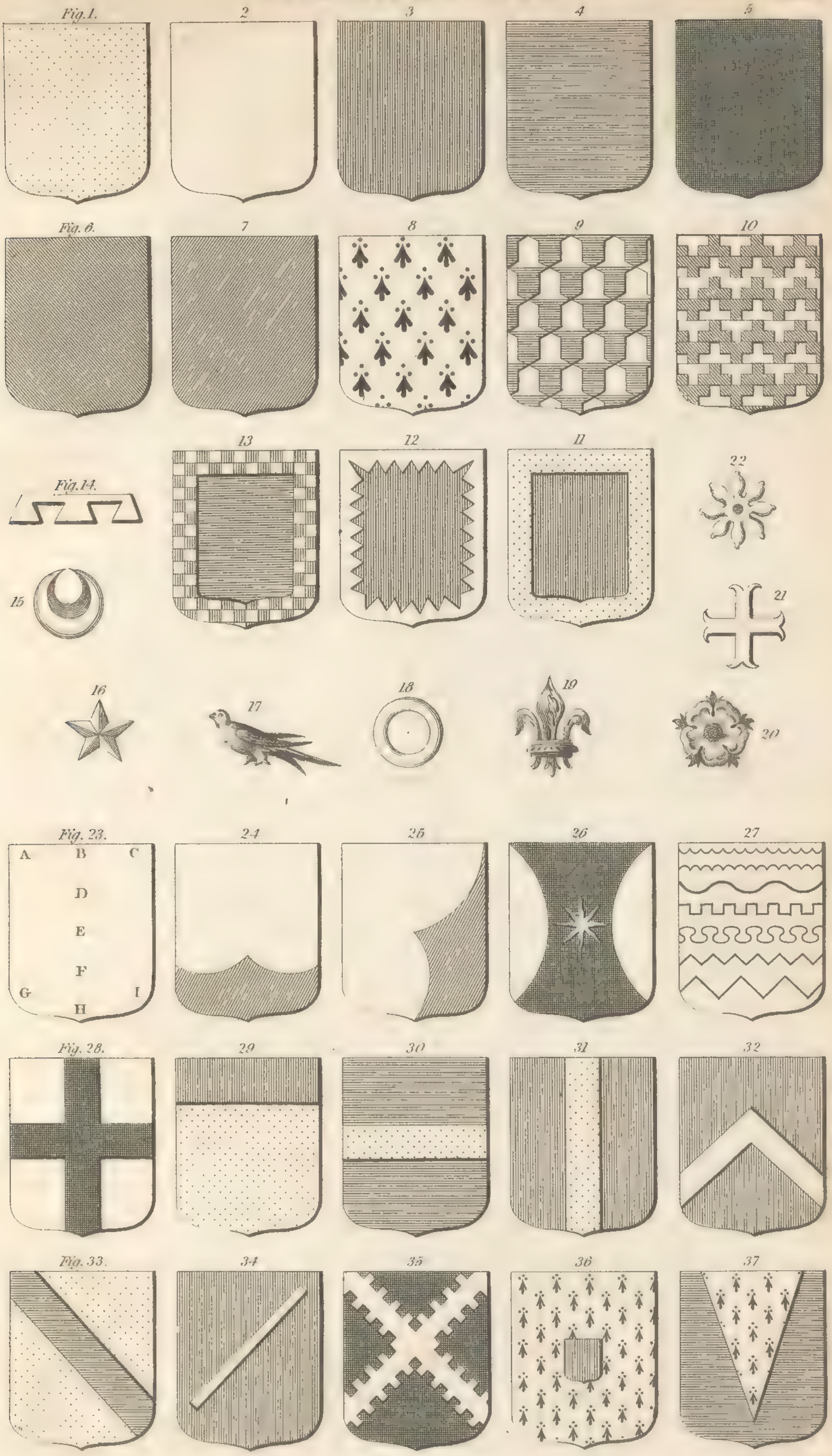
Cooper sculp.

HERALDRY. Plate I.



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to him who is next heir of blood, and not to an executor or administrator, as chattels do. It is a word of large extent, and much used in conveyances; for by the grant of hereditaments, isles, seignories, manors, houses, and lands of all sorts, charters, rents, services, advowsons, commons, and whatever may be inherited, will pass. Hereditaments are of two kinds, corporeal and incorporeal. Corporeal hereditaments consist wholly of substantial and permanent objects, all which may be comprehended under the general denomination of land only; for land comprehends, in its legal signification, any ground, soil, or earth whatsoever, as arable, meadows, pastures, woods, moors, waters, marches, furzes, and heath. Incorporeal hereditaments are not the object of sensation, are creatures of the mind, and exist only in contemplation. They are principally of ten sorts, *viz.* advowsons, tithes, commons, ways, offices, dignities, franchises, presents, and rents.

HERIOT, in law, signifies a tribute given to the lord for his better preparation towards war. And by the laws of Canute, it appears, that at the death of the great men of this nation, so many horses and arms were to be paid for, as they were in their respective life-times obliged to keep for the King's service. A heriot was first paid in arms and horses; it is now by some custom sometimes the best live beast which the tenant dies possessed of, sometimes the best inanimate goods, under which a jewel or piece of plate may be included. Some are due by custom, some by tenure, and by reservation on deeds executed within time of memory; those due by custom are the most frequent.

For an heriot service, or for an heriot reserved by way of tenure, the lord may either seize or distrain.

HERISSON, in fortification, a beam armed with a great number of iron spikes, with their points outwards, and supported by a pivot, on which it turns.

HERITIERA, in botany, so named in honour of Charles Louis L'Heritier, a genus of the Monoecia Monadelphia class and order. Essential character: calyx five-toothed; corolla none; male anthers ten, without filaments; female germs five; drupes with one subglobular seed. There is but one species, *viz.* H. littoralis, looking-glass plant, a native of the East Indies.

HERMANNIA, in botany. This name was given in honour of the celebrated Paul Hermann, a genus of the Monadelphia Pentandria class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: styles five; capsule five-celled; petals semitubular at the base, oblique. There are twenty-one species. The hermannias are shrubs from two to seven feet in height. Natives of the Cape of Good Hope.

HERMAPHRODITE, a term formerly applied exclusively to signify a human creature possessed of both sexes. The term is now applied to other animals, and to plants. It is now well known there is no such thing as an hermaphrodite in the human species. In most species of animals, the production of hermaphrodites appears to be the effect of chance, but in the black cattle it seems to be an established principle of their propagation. It is a well known fact, and, as far as has yet been discovered, appears to be universal, that when a cow brings forth two calves, one of them a bull, and the other a cow to appearance, the cow is unfit for propagation, but the bull-calf becomes a very proper bull. They are known not to breed; they do not shew the least inclination for the bull, nor does the bull ever take the least notice of them. Among the country people in England, this kind of calf is called a free-martin; and this singularity is just as well known among the farmers as either cow or bull. When they are preserved, it is for the purposes of an ox or spayed heifer; *viz.* to yoke with the oxen, or fatten for the table. They are much larger than either the bull or the cow, and the horns grow longer and bigger, being very similar to those of an ox. The bellow of a free-martin is also similar to that of an ox, and the meat is similar to that of the ox or spayed heifer, *viz.* much finer in the fibre than either the bull or cow, and they are more susceptible of growing fat with good food.

Among the reptile tribe, indeed, such as worms, snails, leeches, &c. hermaphrodites are very frequent. In the memoirs of the French Academy, we have an account of this very extraordinary kind of hermaphrodites, which not only have both sexes, but do the office of both at the same time. Such are earth-worms, round-tailed worms found in the intestines of men and horses, land-snails, and those of fresh waters, and all the sorts of leeches. And as all these are reptiles, and without bones, it is inferred that all other insects which have these two characters are also hermaphrodites. The method of coupling practised in this class

of hermaphrodites, may be illustrated in the instance of earth-worms. These little creatures creep, two by two, out of holes proper to receive them, where they dispose their bodies in such a manner, as that the head of the one is turned to the tail of the other. Being thus stretched lengthwise, a little conical button, or papilla, is thrust forth by each, and received into an aperture of the other, these animals being male in one part of the body and female in another.

Among the insects of the soft or boneless kind, there are great numbers indeed which are so far from being hermaphrodites, that they are of no sex at all. Of this kind are all the caterpillars, maggots, and worms, produced of the eggs of flies of all kinds. But the reason of this is plain: these are not animals in a perfect state, but disguises under which animals lurk. They have no business with the propagating of their species, but are to be transformed into animals of another kind, by the putting off their several coverings; and then only they are in their perfect state, and, therefore, then only show the differences of sex, which are always in the distinct animals, each being only male or female. These copulate, and their eggs produce those creatures which show no sex till they arrive at that perfect state again.

HERMAPHRODITE *flowers*, in botany, are so called on account of their containing both the antheræ and stigma, the supposed organs of generation within the same calyx and petals. Of this kind are the flowers of all the classes in Linnæus's method, except the classes Monoecia and Dioecia; in the former of which, male and female flowers are produced on the same root; in the latter, in distinct plants from the same seed. In the class Polygamia, there are always hermaphrodite flowers mixed with male or female, or both, either on the same or distinct roots. In the plaintain-tree the flowers are all hermaphrodite; in some, however, the antheræ or male organ, in others the stigma, or female organ, proves abortive. The flowers in the former class are styled female hermaphrodites; in the latter, male hermaphrodites. Hermaphrodites are thus as frequent in the vegetable kingdom as they are rare and scarce in the animal one.

HERMAS, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: hermaphrodite, umbel terminating; involucre universal and partial; umbellets with truncate rays, the central one floriferous; petals five; stamina five, barren; seeds in pairs, suborbiculate: male, umbels lateral, with universal and partial involucres; umbellets many-flowered; petals five; stamina five, fertile. There are five species.

HERMETICAL *seal*, among chemists, a method of stopping glass vessels, used in chemical operations, so closely, that the most subtle spirit cannot escape through them. It is commonly done by heating the neck of the vessel in a flame, till ready to melt, and then twisting it closely together with a pair of pincers. Or vessels may be hermetically sealed by stopping them with a glass plug, well luted.

HERNANDIA, in botany, from Francis Hernandez, a genus of the Monoecia Triandria class and order. Natural order of Tricoccæ. Lauri, Jussieu. Essential character: male, calyx three-parted; corolla three-petalled: female, calyx truncate, quite entire; corolla six-petalled; drupe hollow, with an open mouth, and a moveable nucleus. There are two species, *viz.* H. sonora, whistling hernandia; and H. ovigera, egg-fruited hernandia. The first mentioned is an upright lofty tree, with a beautiful head; the flowers are of a pale yellow colour, in panicled racemes; the calyxes of the fruit are also yellow. It is very common in the West Indies, in gullies, near rills of water; the English there call it jack in a box. Dr. Patrick Browne attributes the whistling noise to the cups that sustain and partly envelope the nuts; these he adds are very large, and as they move in the wind, produce sound enough to alarm unwary travellers. The seeds are very oily.

HERNIARIA, in botany, English *rupture-wort*, a genus of the Pentandria Digynia class and order. Natural order of Holoraceæ. Amaranthi, Jussieu. Essential character: calyx five-parted; corolla none; stamina five, barren, besides the fertile ones; capsule one-seeded. There are four species; as none of these plants possess any beauty, they are rarely cultivated in gardens.

HERON, in ornithology, a bird of the ardea kind, with a hanging crest. See ARDEA.

HERRING. See CLUPEA.

HESPERIDÆ, the name of the nineteenth order in Linnæus's fragments of a natural method, consisting of five genera, among which are the caryophyllus or clove-

tree; and the myrtus, myrtle; allspice or pimento. The plants of this order are of the shrub and tree-kind, and chiefly evergreen. The bark of the stalks is slender; the leaves are generally opposite, but in the myrtle, the leaves are placed opposite at the bottom of the stalks, and alternate above. The buds are generally conical, concealed in the cavity, which is formed by the footstalk of each leaf at its origin. The flowers are commonly hermaphrodite: in a species of the myrtus, however, they are male and female upon different roots. The calyx is placed above the seed-bud: the petals are three, four or five in number; the stamina are upwards of twenty, nearly equal, and attached in several rows to the middle of the tube of the calyx. The seed-bud is large, and placed below the receptacle of the flower; the style is single, of the length of the stamina, and terminated with a single stigma. The seed vessel is sometimes a berry, sometimes a capsule, and sometimes a stone.

HESPERIS, in botany, English *rocket*, or *dames violet*, a genus of the Tetradynamia Siloquosa class and order. Natural order of Siliquosæ. Cruciformes, Tournefort. Cruciferæ, Jussieu. Essential character: petals bent obliquely; a gland within the shorter stamens; siliqua stiff; stigma with a forked base, and converging tip; calyx closed. There are seven species. These plants are much cultivated for the great fragrancy of the flowers: th ladies in Germany have pots of it placed i their apartments, whence it obtained the name of dames violet.

HETEROCLITE, among grammarians, one of the three variations in irregular nouns, and defined by Mr. Ruddiman, a noun that varies in declension. Other grammarians take the word heteroclite in a larger sense, applying it to all irregular nouns.

HETEROGENOUS, or Heterogeneal, something that consists of parts of dissimilar kinds, in opposition to homogeneous.

Heterogeneous, in mechanics, such bodies whose density is unequal in different parts of their bulk; or they are such whose gravities in different parts are not proportionable to the bulks thereof; whereas bodies equally dense or solid in every part, or whose gravity is proportionable to their bulk, are said to be homogeneous.

Heterogeneous *light*, is, by Sir Isaac Newton, said to be that which consists of rays of different degrees of refrangibility: thus the common light of the sun or clouds is heterogeneous; being a mixture of all sorts of rays.

Heterogeneous *nouns*, one of the three variations in irregular nouns; or such as are of one gender in the singular number, and of another in the plural. Heterogeneous, under which are comprehended mixed nouns, are six-fold. 1. Those which are of the masculine gender in the singular number, and neuter in the plural. 2. Those which are masculine in the singular number, but masculine and neuter in the plural. 3. Such as are feminine in the singular number, but neuter in the plural. 4. Such nouns as are neuter in the singular number, but masculine in the plural. 5. Such as are neuter in the singular, but neuter and masculine in the plural. 6. Such as are neuter in the singular, but feminine in the plural number.

Heterogeneous *numbers*, mixed numbers consisting of integers and fractions.

Heterogeneous *quantities*, are those which are of such different kinds, as that one of them taken any number of times, never equals or exceeds the other.

Heterogeneous *surds*, are such as have different radical signs, as $\sqrt[2]{aa}$, $\sqrt[5]{bb}$, $\sqrt[3]{9}$, $\sqrt[7]{18}$, &c. See Surd.

If the indices of the powers of the heterogeneous surds be divided by their greatest common divisor, and the quotients be set under the dividends; and those indices be multiplied crosswise by each others quotients; and before the products be set the common radical sign $\sqrt{}$, with its proper index; and if the powers of the given roots be involved alternately, according to the index of each others quotient, and the common radical sign be prefixed before those products, then will those two surds be reduced to others, having but one common radical sign.

HEUCHERA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Succulentæ. Saxifragæ, Jussieu. Essential character: petals five; capsule two-beaked, two-celled. There are two species, *viz.* H. americana, American heuchera or sanicle, and H. dichotoma.

HETEROSCII, in geography, a term of relation denoting such inhabitants of the earth as have their shadows falling but one way, as those who live between the tropics and polar circles, whose shadows at noon, in north latitude, are always to the northward; and in south latitude, to the southward. Thus we who inhabit the northern temperate zone, are heteroscii with regard

to those who inhabit the southern temperate zone, and they are heteroscii with respect to us. Hence it follows, that only the inhabitants of the two temperate zones are heteroscii, though in reality there is always one part of the torrid zone whose inhabitants are heteroscii with respect to those of the rest, and with regard to those of one of the temperate zones, except at the time of the solstice, and even at this time all of the torrid zone are heteroscii with regard to those of one of the temperate zones; but as the people of the torrid zone have their shadows now on this, and then on that side, they are called amphiscii.

HEXACHORD, in ancient music, a concord called by the moderns a sixth. The hexachord is twofold, greater and less. The greater hexachord is composed of two greater tones, and two less, and one greater semitone, which make five intervals. The less hexachord is of two greater tones, one lesser, and two greater semitones.

HEXAEDRON, or HEXAHEDRON, one of the five regular or platonic bodies; being indeed the same as the cube; and is so called from its having six faces. The square of the side or edge of a hexahedron, is one-third of the square of the diameter of the circumscribing sphere; and hence the diameter of a sphere is to the side of its inscribed hexahedron, as $\sqrt{3}$ to 1. See BODY.

HEXAGON, in geometry, a figure of six sides and angles; and if these sides and angles be equal it is called a regular hexagon. The side of every regular hexagon, inscribed in a circle, is equal in length to the radius of that circle. Hence, it is easy, by laying off the radius six times upon the circumference, to inscribe an hexagon in a circle. See GEOMETRY.

To describe a regular hexagon upon a given line, describe an equilateral triangle upon it, the vertex of which will be the centre of the circumscribing circle. The side of a hexagon being s, the area will be

$$2.598\, s^2 = \frac{3}{2} s^2 \times \text{tang. } 60° = \frac{3}{2} s^2 \sqrt{3}.$$

HEXAGON, in fortification, is a place defended by six bastions.

HEXAGYNIA, in botany, the name of an order of plants, consisting of those which, besides their classical character, have their flowers furnished with six styles.

HEXAMETER, in ancient poetry, a kind of verse consisting of six feet; the first four of which may be indifferently, either spondees or dactyls; the fifth is generally a dactyl, and the sixth always a spondee. Such is the following verse of Horace:

1 2 3 4 5 6
Aut pro|desse vo|lunt, aut|dele|ctare po|etæ.

Sometimes, indeed, a spondee constitutes the fifth foot; whence such hexameter verses are called spondaic; as in this of Virgil.

1 2 3 4 5
Cara De|um sobo|les ma|gnum Jovis | incre-|
6
mentum.

Epic poems, as the Iliad, Æneid, &c. consist wholly of hexameter verses; whereas elegies and epistles consist usually of hexameter and pentameter verses, alternately.

HEXANDRIA, the name of the sixth class in the Linnæan system, consisting of plants with hermaphrodite flowers, which are furnished with six stamina or male organs that are of an equal length. This numerous class of plants is divided into five sections, from the number of the styles or female organs: the narcissus, snow-drop, tulip, hyacinth, &c. have one style; the rice, atraphaxis, &c. two; dock, star-flower, &c. three; guinea-hen weed, four; and water-plantain five. The Hexandria class is distinguished from the Tetradynamia by the proportion of the stamina, which in the former are of an equal length, in the latter unequal, four stamina being long, and two short.

HIATUS, properly signifies an opening, chasm, or gap; but it is particularly applied to those verses, where one word ends with a vowel, and the following word begins with one, and thereby occasion the mouth to be more opened, and the sound to be very harsh.

The term hiatus is also used in speaking of manuscripts, to denote their defects, or the parts that have been lost or effaced.

HIBISCUS, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double; outer many-leaved; capsule five-celled, with many seeds. There are forty-five species, most of these are perennials; several of them have shrubby stalks; and some are herbaceous; the leaves are alternate and commonly of a soft texture. The flowers are of the mallow kind, axillary, and terminating; the bark in several is capable of being drawn into threads, and manufactured for packthread and ropes; the capsule in some is eatable; others are much esteemed for their ornamental flowers.

HIDE. See CUTIS.

HIDE. Hides are the skins of beasts:

but the denomination is particularly applied to those of large cattle, as bullocks, cows, buffaloes, horses, &c. Raw hides are still a considerable object in the Egyptian trade: about 80,000 hides of buffaloes, camels, cows, and oxen, are exported yearly. Nearly 10,000 go to Marseilles, and a still greater number to Italy. The buffaloe hides being thicker and heavier than the others, are chiefly transported to Syria. As the pastures of Lower Egypt are excellent, the hides of its cattle, in consequence of their being so well fed, are of the very best quality. Great numbers of buffaloes are also in North America. They are larger than an ox, and their head is so full of hair that it falls over their eyes, and gives them a frightful look. There is a bunch on their back, which begins at the haunches, and encreasing gradually to the shoulders, reaches on to the neck. The whole body is covered with long hair, or rather wool, of a dun or mouse colour, which is exceedingly valuable, especially that on the forepart of the body, being proper for the manufacture of various articles. The hide makes a considerable article of export from America. There are hides of several denominations, according to their state and quality. Raw or green hide, is that which has not undergone any preparation, being in the same condition as when taken off the carcase. There are also hides dried in the hair. Salted hide, is a green hide seasoned with sea-salt and alum, or salt-petre, to prevent its corruption. Most of the hides imported from Holland and France are so prepared. Tanned hides are further prepared by the tanner, by paring off the hair, and steeping them in pits of lime and tan. Curried hides are those which, after tanning, have passed through the curriers' hands, and have thus received their last preparation, so as to be fit for use.

HIDE *of land*, was such a quantity of land as might be ploughed with one plough within the compass of a year, or so much as would maintain a family; some call it sixty, some eighty, and some an hundred acres.

The distribution of this kingdom by hides of land is very ancient, mention being made of it in the laws of King Ina. Henry I. had three shillings for every hide of land, in order to raise a dowry for his daughter: this tax was called hidage.

HIERACIUM, in botany, English *hawkweed*, a genus of the Syngenesia Polygamia Aequalis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx imbricate, ovate; down simple, sessile; receptacle naked. There are fifty-five species: most of these plants are reputed to be weeds; few of them are cultivated except in botanic gardens.

HIERARCHY, denotes the subordination of the clergy, ecclesiastical polity, or the constitution and government of the Christian Church considered as a society.

HIERO'S *crown*. Under the article ARCHIMEDES we have given an account of the interesting fact to which this phrase alludes; we shall only add here, an example to shew how the fraud was detected by a simple arithmetical process: suppose each of the three masses above referred to weighed 64 ounces, and that immersing them separately in the same vessel of water, there were displaced 5*oz.* of water by the golden ball, 9*oz.* by the silver, and 6*oz.* by the compound, or the crown itself, then the respective bulks being as the quantities of water displaced, will be as 5, 9, and 6; and we say,

$$\begin{array}{r} 9 - 6 = 3 \\ 6 - 5 = 1 \\ \hline 4 \end{array}$$

$$4 : 64 :: 3 : 48$$
$$4 : 64 :: 1 : 16$$

And under such circumstances the crown consisted of 48*oz.* of gold and 16 of silver.

HIEROGLYPHICS, in antiquity, mystical characters, or symbols, in use among the Egyptians, and that as well in their writings as inscriptions; being the figures of various animals, the parts of human bodies, and mechanical instruments.

But besides the hieroglyphics in common use among the people, the priests had certain mystical characters, in which they wrapped up and concealed their doctrines from the vulgar. It is said that these something resembled the Chinese characters, and that they were the invention of Hermes. It has been thought that the use of these hieroglyphical figures of animals introduced the strange worship paid them by that nation: for as these figures were made choice of, according to the respective qualities of each animal, to express the qualities and dignity of the persons represented by them, who were generally their gods, princes, and great men, and being placed in their temples as the images of their deities; hence they came to pay a superstitious veneration to the animals themselves.

The meaning of a few of these hieroglyphics has been preserved by ancient writers. Thus we are told they represented

the Supreme Deity by a serpent, with the head of a hawk. The hawk itself was the hieroglyphic of Osiris; the river-horse, of Typhon; the dog, of Mercury; the cat, of the moon, or Diana; the beetle, of a courageous warrior; a new-born child, of the rising sun; and the like.

HIEROGLYPHICS. See WRITING, *origin of*.

HIGHWAY, a public passage for the king's people; whence it is called the king's highway. It seems that anciently there were but four highways in England which were free and common to all the king's subjects, and through which they might pass without any toll, unless there were a particular consideration for it. All others which we have at this day are supposed to have been made through the grounds of private persons, on writs of *ad quod dammum*, &c. which being an injury to the owner of the soil, it is said they may prescribe for toll without any special consideration.

There are three kinds of ways, a footway, a pack and prime way, which is both a horse and foot way, and a cart-way, which contains the other two. But notwithstanding these distinctions, it seems that any one of these ways which is common to all the king's subjects; whether it lead directly to a market town, or only from town to town, may properly be called an highway, and that any such cartway may be called the king's highway. A river, common to all men, may also be called the king's highway; and that nuisances in any such ways are punishable by indictment; otherwise they would not be punished at all; for they are not actionable unless they cause a special damage to some particular person; because if such action would lie, a multiplicity of suits would ensue.

If passengers have used, time out of mind, where the roads are bad, to go by outlets on the land adjoining to an highway in an open field, such outlets are parcels of the highway; and, therefore, if they are sown with corn, and the track is foundrous, the king's subjects may go upon the corn.

Repairing highways. By the common law, the general charge of repairing all highways lies on the occupiers of the lands in the parish wherein they are. But it is said that the tenants of the lands adjoining are bound to scour their ditches.

Particular persons may be burdened with the general charge of repairing an highway, in two cases; in respect of an inclosure, or by prescription. As where the owner of lands not enclosed, next adjoining to the highway, incloses his lands on both sides thereof; in which case he is bound to make a perfect good way, and shall not be excused for making it as good as it was at the time of the inclosure, if it were then any way defective; because, before the inclosure, when the way was bad the people, for their better passage, went over the fields adjoining out of the common track, a liberty which the inclosure has deprived them of. Particular persons may be bound to repair an highway by prescription. But in all cases, whether a private person be bound to repair an highway by inclosure or prescription, the parish cannot take the advantage of it on the general issue, but must plead it specially; and, therefore, if to an indictment against the parish for not repairing an highway, they plead not guilty, this shall be intended only that the ways are in repair, or that it is not an highway, but does not go to the right of reparation.

At common law, it is said that all the country ought to make good the reparations of an highway, where no particular persons are bound to do it; by reason the whole county have their ease and passage by the said way.

By the ancient common law, villages are to repair their highways, and may be punished for their decay; and, if any do injury to, or straighten the highway, he is punishable in the King's Bench, or before the justices of peace in the court leet, &c. Destroying any public turnpike-gate, or the rails or fences thereto belonging, subjects the offender to hard labour for three months, and to be publicly whipped. 1 Geo. II. c. 19. On conviction at the assizes, the offender may be transported for seven years. And on a second offence, or on demolishing any turnpike-house, he shall be guilty of felony, and transported for seven years. But in both these cases the prosecution must be within six months; and on the convict's returning from transportation he shall suffer death. 5 Geo. II. c. 33.

Every justice of the peace, by the statute, upon his own view, or on oath made to him by the surveyor, may make presentment of roads being out of repair; and, thereupon, like process shall be issued as upon indictment. For the repairing of highways, there are certain regulations, by statute; and every inhabitant of a parish is bound to perform certain duties for that purpose.

HIGH *water*, that state of the tides, when they have flowed to the greatest height, or have ceased to flow. It is high-water several minutes, as many as between 15 and 30, before it begins to ebb again.

The mode of computing high-water is by having the moon's age given, of which take $\frac{4}{5}$, and adding it to the time of high-water on the day of full or change, and the sum is nearly equal to the time of high-water. Thus, for the present day, the 29th of May, it was new moon, or change, on the 25th, of course the moon is four days old; and on the 25th it was high-water at about two o'clock; therefore $4 \times \frac{4}{5} + 2 = 5^h 12^m$, or to about twelve minutes after five.

HILLIA, in botany, so named in honour of Sir John Hill, M. D., author of many works in botany, a genus of the Hexandria Monogynia class and order. Natural order of Contortæ. Rubiaceæ, Jussieu. Essential character: calyx double, lower six-leaved; corolla very long, contorted; capsule two-celled, two-valved, crowned; seeds downy. There are two species, *viz.* H. longiflora, and H. tetrandria; both natives of Jamaica.

HIN, a Hebrew measure of capacity for things liquid, containing the sixth part of an epha, or one gallon two pints, English measure.

HIND, a female stag in the third year of its age. See CERVUS.

HINGES, the joints on which gates, doors, lids, folds of tables, &c. hang and turn in opening, shutting, or folding. They are of different denominations, as butts, used by the joiners for hanging table-leaves, &c.; casement, for hanging casements upon dove-tails; and esses, for light doors and lockers; garnet-cross, for hanging large doors or heavy scuttles in ships; port, for hanging ships' ports; scuttle, particularly used for scuttles. Besides these, there are many others of different forms and uses, distinguished by different names.

HIPS, in building, those pieces of timber placed at the corner of a roof.

HIP *roof*, among carpenters, called also *Italian roof*, is a roof which has neither gable-head, shread-head, nor jerken-head (by which is meant such heads as are both gable and hip at the same end): for it is a gable, or upright, as high as the collar-beam, and then there are two short hips, which shut up with their tops to the tops of a pair of rafters, which country carpenters call singlars. A hip-roof has rafters as long, and with the angles of the foot, &c. at the ends of buildings, as it has at the sides; and the feet of the rafters, at the ends of such buildings as have hip-roofs, stand on the same plane, *viz.* parallel with the horizon, and at the same height from the foundation, with rafters on the sides of the roof.

HIPPIA, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx hemispherical, subimbricate, corollets of the ray ten, obsolete, subtrifid; seeds with very broad margins, naked; down none; receptacle naked. There are three species.

HIPPOBOSCA, in natural history, a genus of insects of the order Diptera. Mouth with a short, cylindrical, straight, two-valved sucker; the valves are equal; antennæ filiform; feet armed with numerous claws; body flat and hard. There are five species, of which the most familiar is H. equina, or horse-fly: head brown; thorax brown, varied with pale colour; wings crossing each other, hyaline with a brown spot near the outer margin; legs annulate with yellow and brown. This insect is exceedingly troublesome to horses; it hides itself under the hairs, and fixes to the skin by means of their crooked nails. It varies in size, in different districts, but is largest in the southern and warm climates. The skin of the insect is of a strong and coriaceous nature; hence it may be pressed to a considerable degree, without being apparently injured. The female of this insect deposits a single egg at distant intervals; but as the egg undergoes no further alteration of form, it has been regarded rather as a pupa than an egg; it continues perfectly inert, but changes colour; and, if opened after a certain period, it exhibits the fly in its unadvanced state, and of a white colour. It not unfrequently lies during the whole winter in this state, the fly emerging in the following summer. H. avicularia, is observed on the bodies of various birds, which it infests. H. hirundinis is, as its name imports, to be found in the nests and on the bodies of swallows, swifts, and martins. H. ovina, is without wings; it is known by the name of the sheep-tick, and is found imbedded in the wool of these animals; this is so tenacious of life, that it has been found in wool that has been a long time packed up in fleeces.

HIPPOCRATEA, in botany, so named in memory of Hippocrates, the famous Greek physician; a genus of the Triandria Monogynia class and order. Natural order of Acera, Jussieu. Essential character: calyx five-parted; petals five; capsule three, obcordate or elliptic. There are two species, *viz.* H. volubilis, and H. comosa.

HIPPOCREPIS, a genus of the Diadelphia Decandria class and order. Natural

order of Leguminosæ or Papilionaceæ. Essential character: legume compressed, several times emarginate along one of the sutures, curved. There are five species. These are small herbaceous plants, with unequally-pinnate leaves and small stipules; peduncles axillary, and terminating, one or many-flowered, in umbels; corollas mostly yellow. Natives of the South of Europe.

HIPPOMANE, in botany, a genus of the Monoecia Monadelphia class and order. Natural order Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, ament; perianthum bifid; corolla none: female, perianthum trifid; corolla none; stigma three-parted; drupe or capsule three-grained. There are three species; of which H. mancinella, manchineel tree, is exceedingly large in the West Indies, almost equalling the oak in size. The first accounts of this tree were very much exaggerated; it was said to be dangerous to sit or lie under it, and that the rain which falls from the leaves will raise blisters in the skin. Professor Jacquin informs us, that he and his companions reposed upwards of three hours under a manchineel tree, without receiving any injury; and that he experienced rain dropping from the leaves to be perfectly innocent. It is dangerous to eat of the fruit, which resembles crab-apples, it occasions vomiting, and a burning heat in the mouth, throat, and stomach, for many hours after. The juice of the buds of the white cedar is esteemed an antidote to this poison, and is generally used with success. It is said, that goats, sheep, and macaws feed greedily on the fruit. The wood is very much esteemed, and is used for ornamental purposes.

HIPPOPHAE, in botany, a genus of the Dioecia Tetrandria class and order. Natural order of Calycifloræ. Elæagni, Jussieu. Essential character: male, calyx two parted; corolla none: female, calyx bifid; corolla none; style one; berry one-seeded. There are two species, *viz.* H. rhamnoides, common sea-buckthorn, and H. canadensis, Canadian sea-buckthorn.

HIPPOPOTAMUS, in natural history, a genus of Mammalia, of the order Belluæ. Generic character: four front-teeth in each jaw; the upper ones distant, in pairs; the lower ones prominent; the two intermediate ones longest; tusks solitary; those of the lower jaw very large, long, curved, and obliquely truncated; feet hoofed at the margin. This animal appears very naturally to have attracted the early attention of mankind, and is supposed, by most critics acquainted with natural history, to be the behemoth so sublimely described in the book of Job. The Greek and Roman writers have also alluded to it; but their observations upon it are by no means such as could have resulted from accurate and philosophical observation; and both Aristotle and Pliny have fallen, on this subject, into the most absurd deviations from truth. Indeed it is only recently, that clear and just representations of this animal have been published, with interesting circumstances relating to its manners and habits, collected by persons who had inclination and opportunities of particularly examining it. Dr. Sparman, and Colonel Gordon, and Mr. Mason, are particularly entitled to honourable mention on this occasion. The largest female which the Colonel ever had an opportunity of observing, was eleven feet in length, and the largest male nearly twelve. It is stated, however, on respectable authority, that they are frequently much larger; and Mr. Bruce reports, that they are occasionally found even of the length of twenty feet. The form of the hippopotamus is particularly aukward: its head is astonishingly large, and its body extremely fat and round; its legs are very short and thick, and its teeth are of vast strength and size, one of them is stated to weigh no less than three pounds, occasionally, each of the tusks weighs even six; the whole animal is covered with short hair; its skin is so tough, as in some parts to resist a bullet; and its colour, when dry, is an obscure brown. It inhabits the warmer latitudes, and is to be found chiefly in the interior of Africa, dwelling in the largest rivers, in which it ranges at the bottom, sometimes reaching the surface for the purpose of respiration. It sometimes quits the rivers for the sea, merely, as is supposed, for the sake of expatiating with greater freedom, as it never drinks salt water, and eats no fish, and indeed takes no animal food whatever. By night it quits the water to feed, and devours a vast quantity of grass, and the tender branches of trees. Its disposition has nothing in it sanguinary or ferocious; it never attacks other animals. It frequently commits great depredations on the plantations of corn or sugar, which are within the reach of its nocturnal progresses, and by destroying with its vast teeth the roots of trees. Its motion on land is generally not only highly inelegant, but slow; yet if surprized and pursued, it runs with great speed till it reaches the water, into which it instantly plunges; and, though

it is able to swim with great rapidity, its progress in the water is at the bottom by walking. If wounded in the water, it sometimes is highly infuriated, and has been known to attack the boats or canoes, which it supposed to contain its enemy, and overturn them by its vast strength, or sink them by making a large hole in them with its teeth. It produces but one at a birth, generally in the little rushy isles of the rivers which it frequents, and in these islets it generally sleeps. When taken young, it is capable of being tamed. These animals are sometimes seen in considerable numbers, ranging for several miles beyond the banks of their rivers. They are often shot by the Africans, and frequently taken by the harpoon; pitfalls also are sometimes dug for them. They are valued by the natives of Africa for food, and the fat which it supplies is supposed to be equal to that of the hog. The feet are highly gelatinous, and regarded as a particular delicacy. With their skins the warriors of Africa are furnished with shields and bucklers. The grand motive to destroy these animals, however, is the value of their tusks, which are whiter than those of the elephant, and retain their original clearness and beauty. They are likewise of a harder consistence, and are, on both these accounts, preferred by dentists, for artificial teeth, to every other substance.

In the Ædileship of Scaurus a temporary lake was formed, into which he introduced four crocodiles and a hippopotamus, for the entertainment of the Roman people; and Augustus, in his triumph over Cleopatra, amidst many other objects characteristic of Egypt, exhibited a hippopotamus. In Upper Egypt, and in the fens of Ethiopia, traversed and inundated by the Nile, these animals are more particularly abundant. For the hippopotamus, see Mammalia, Plate X. fig. 2.

HIPPURIS, in botany, *mare's-tail*, a genus of the Monandria Monogynia class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character: calyx a two-lobed rim to the germ; corolla none; stigma simple; seed one. There are three species.

HIRÆA, in botany, so named from Nicol de la Hire, a genus of the Decandria Trigynia class and order. Natural order of Trihilatæ. Malpighiæ, Jussieu. Essential character: calyx five-leaved; petals roundish, on claws; capsule three-celled, with three wings; seeds two. There is only one species, *viz.* H. reclinata, a native of Carthagena in New Spain.

HIRCUS, in anatomy, a part of the auricle or outer ear, being that eminence next the temple. See EAR.

HIRCUS, *a goat*, in astronomy, a star of the first magnitude, the same with Capella. See CAPELLA.

HIRCUS is also a name used by some writers for a comet, encompassed, as it were, with a mane, seemingly rough and hairy.

HIRTELLA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rosaceæ, Jussieu. Essential character: petals five; filaments very long, permanent, spiral; style lateral; berry one-seeded. There are three species.

HIRUDO, the *leech*, in natural history, a genus of the Vermes Intestina class and order. The body moves either forward or backward. There are seventeen species, principally distinguished by their colour. The most remarkable are the following:

H. medicinalis, or medicinal leech, the form of which is well known, grows to the length of two or three inches. The body is of a blackish-brown colour, marked on the back with six yellow spots, and edged with a yellow line on each side; but both the spots and the lines grow faint, and almost disappear at some seasons. The head is smaller than the tail, which fixes itself very firmly to any thing the creature pleases. It is viviparous, and produces but one young at a time, which is in the month of July. It is an inhabitant of clear running waters, and is well known for its use in bleeding.

H. muricata, or muricated leech, has a taper body, rounded at the greater extremity, and furnished with two small tentacula, or horns, strongly annulated and rugged upon the rings, the tail dilated. It inhabits the Atlantic ocean, and is by the fishermen called the sea-leech. It adheres to fish, and generally leaves a black mark on the spot.

The mouth of the leech is armed with a sharp instrument, that makes three wounds at once, and may be compared to the body of the pump, and the tongue or fleshy nipple to the sucker: by the working of this piece of mechanism the blood is made to rise up to the conduit which conveys it to the animal's stomach, which is a membranaceous skin, divided into twenty-four cells. The blood which is sucked out is there

preserved for several months, almost without coagulating, and proves a store of provision to the animal. The nutritious parts, pure and already digested by animals, have no call to be disengaged from the heterogeneous substances: nor indeed is there an anus discoverable in the leech; mere transpiration seems to be all that it performs, the matter fixing on the surface of its body, and afterwards coming off in small threads. Of this an experiment may be tried, by putting a leech into oil, where it keeps alive for several days: upon being taken out, and put into water, there appears to loosen from its body, a kind of slough, shaped like the creature's body. The organ of respiration, though unascertained, seems to be situated in the mouth; for if, like an insect, it drew its breath through vent-holes, it would not subsist in oil, as by it they would be stopped up.

It is only the first species that is used in medicine, being applied to the skin in order to draw off blood. With this view they are employed to phlebotomise young children. If the leech does not fasten, a drop of sugared milk is put on the spot it is wished to fix on, or a little blood is drawn by means of a slight puncture, after which it immediately settles. The leech, when fixed, should be watched, lest it should find its way into the anus when used for the hemorrhoids, or penetrate into the œsophagus if employed to draw the gums, as it would make great havoc in the stomach or intestines. In such a case, the best and quickest remedy is to swallow some salt; which is the method practised to make it loose its hold when it sucks longer than was intended.

H. sanguisuga, horse-leech: elongated, olive-brown, with an ochre-yellow marginal band: found in stagnant waters, ditches, and ponds: from four to six inches long: body above dull olive-black, with an ochre margin on each side; beneath paler, with sometimes a few black spots: tail thicker than the head. This species sucks blood with great avidity, and in large quantities. H. viridis: body depressed, oblong, green, with a transparent margin and pointed tail. This species has been described by Dr. Shaw in the "Transactions of the Linnæan Society:" it inhabits clear cold waters, is about the eighth of an inch long, and like most of the genus has a power of reproduction almost equal to that of the polype; for if the animal be divided in every direction, the parts will become perfect animals, and may be again divided and again reproduced. It is of a grass-green colour, with a transparent border all round. H. geometra, or geometrical leech: body filiform, greenish, spotted with white; both ends dilatable, and equally tenacious. It inhabits fresh waters: moves as if measuring like a compass, whence the name: it is found on trout and other fish, after the spawning season.

HIRUNDO, the *swallow*, in natural history, a genus of birds of the order Passeres. Generic character: bill short, depressed at the base, small at the point, and a little bending; nostrils open; tongue short, broad, and cleft; wings long; legs short; tail, in general, forked. These live almost perpetually in the air, and perform in it every act of their nature. They subsist upon the insects with which that element abounds, and which they catch on the wing with the most admirable dexterity; and for this purpose they are furnished with a most extraordinary power of distending their jaws. The service they perform to man by their incessant assiduity in this work of destruction is not lightly to be appreciated, and those who observe the crowded population of the atmosphere through the beams of a summer evening, will easily be led to believe, that, but for the interception of incalculable myriads of insects by these birds, the annoyance of man by these minute animals would be highly distressing, and perhaps almost intolerable. The celerity of this tribe of birds is truly astonishing, and that union of flexibility and speed which they exhibit in pursuit of their prey, or with which they elude the grasp of their enemies, is highly remarkable and interesting. Their manners are eminently entertaining and social. They fix their nests to the habitations of man, and are not only extremely useful in some respects, but perfectly inoffensive in all. Though so much within the observation of man, some circumstances of their economy have hitherto completely baffled the curiosity of the most vigilant observer. Various opinions have been formed of the state in which they exist during the time of their disappearance; some imagining them to lie torpid, in the banks of rivers, or in decayed trees, or in ruined edifices or vaults; and others, that they retire for the winter from the air to the water, lying in immense clusters, like swarms of bees, at the bottoms of rivers. Particular facts are on record, by respectable testimony, in favour of both these hypotheses. It is also attested, on similar authority, that migra-

tions of these birds actually take place. They have frequently been seen by mariners at a vast distance from land, and in very numerous flocks, and have occasionally converted the rigging and yards of vessels into resting places, which have most conveniently relieved their long and wearisome flight. Mr. Pearson of London, after one unsuccessful experiment, was enabled to preserve swallows throughout the winter, taking extreme care to guard their feet from damp and cold. They were in good health, sang with vivacity, and accomplished the process of moulting soon after Christmas, without any particular inconvenience, and for three successive years exhibited the same vigour, health, and animation. From this experiment it might be presumed, that swallows experience no particular deviation in constitution and propensities from other birds, and quit this country towards winter for one where they may enjoy a milder climate, and more plentiful food. They are to be met with in every country of the world, and in all, or nearly so, are found to be migratory. There are thirty-seven species, of which we shall notice the following.

H. rustica, or the house-swallow, appears in March in this country, and leaves it in September. It generally builds in chimneys, or under the eaves of houses, and will return, unless interrupted, to its original haunt for a number of years. For three years in succession a pair of swallows built on the frame of an old picture in Camerton Hall, near Bath, having access to the apartment through a broken pane in the window. These birds breed twice a year. They are easily rendered familiar; and it has been calculated, from what occurred in a curious and extraordinary instance of the domestication of one of them, in the family of a gentleman in Northumberland, that a single swallow will devour from seven hundred to a thousand flies in one day. See Aves, Plate VIII. fig. 2.

H. urbica, or the martin, arrives in this country rather later than the swallow, and remains longer. It builds often in the crags of rocks, near the sea; often under the eaves and cornices of houses. As soon as the young are able to fly, they are fed by the old birds upon the wing, by a process so rapid and instantaneous, as almost to be deemed incredible by those who have not actually witnessed it. Before their departure, they collect in immense flocks in the small islands of the Thames, where they roost, and in their flights about which they almost obscure by their numbers the face of the sky. It is observed, that in comparison with the multitudes which depart, there are extremely few which return. See Aves, Plate VIII. fig. 3.

H. apus, or the swift, arrives later and quits sooner than any other species, and is also larger and stronger. It builds in elevated situations, particularly about churches and steeples. As these birds catch at almost every thing in the air, they are taken sometimes by a cockchaffer, or other insects, tied to a thread. In the Isle of Zante this torturing amusement is practised on them by boys, who catch them indeed often in immense numbers by a string and feathered hook only, which they suspend from some elevated situation. They retire during the heat of the day; but in the morning and evening are incessantly on the wing, taking higher and bolder flights than the swallows, and always keeping separate from them. They leave this island in August. See Aves, Plate VIII. fig. 4.

H. esculenta, or the Chinese swallow, is said to be less than the wren by some authors, while others attribute to it the size of the martin. This bird is principally remarkable for its nest, which, singular as it may appear, is not only used for food, but regarded as one of the greatest luxuries on which the genuine epicure can possibly banquet. The weight of this nest is about half an ounce: it is formed in the shape of a half of a lemon, and composed of many easily discriminated layers of a substance somewhat resembling isinglass. The materials which constitute it have been the subject of considerable diversity of opinion, and are not yet (at least in this country) ascertained. It is chiefly applied in soups and ragouts, made of chickens, and mixed with a considerable quantity of ginseng.

HISPA, in natural history, a genus of insects of the order Coleoptera. Antennæ cylindrical, approximate at the base, and seated between the eyes; feelers fusiform; thorax and shells often spinous or toothed at the tip. There have been twenty-six species enumerated and described, very few of which are to be found in this country. They are separated into three divisions: A. lip-horny, entire. B. lip-membranaceous, subemarginate. C. lip-membranaceous, entire. H. atra is the chief species known in this country, found at the roots of long grass. It is of a deep unpolished black, and has the upper part of the body entirely covered with long and strong

spines, which render it similar to the bristly shell of a chesnut, or to a hedge-hog in miniature. The larva of the hispa is unknown.

HISTER, a genus of insects of the order Coleoptera. Antennæ clavate, the club solid; the last joint compressed, decurved; head retractile within the body; mouth forcipated; shells shorter than the body, truncate; fore-shanks toothed, hind-shanks spinous. There are twenty-four species. The most common European species of the hister genus is H. unicolor, which is of a glossy coal black colour, and of a slightly flattened shape. It is often seen in the gardens, but its larva is unknown.

HISTORIOGRAPHER, a professed historian, or writer of history. An historian, of all authors, spreads the most ample theatre; he erects the greatest tribunal on earth; for it is his office to sit supreme judge of all that passes in the world, to pronounce the destiny of the great ones of the earth, and fix their character with posterity; to do justice to virtue and worth, in bestowing eternity upon great and good actions, and fixing an everlasting mark of infamy on bad ones; to instruct all people and nations, and direct the conduct of ages; he therefore ought to be endowed with many great and uncommon qualifications. He must be a person of consummate knowledge of men and things, of sound judgment, uncommon sagacity and penetration, experienced in matters of state and war, of great integrity, firmness of mind, freedom of sentiment, and master of a pure, clear, nervous, and exalted style. An historian whose province it is to speak to kings and princes, to the great men of all ages and countries, and to be the common master and instructor of mankind, must not only write with purity, simplicity, and manly sense, but with dignity and elegance: he must reject all that is vulgar and low in style, make the majesty and sublimity of his expression comport with the dignity of his subject; must by an exact choice and propriety of words, a natural disposition of phrases, and a prudent moderate use of figures, give weight to his thoughts, force to his language, and imprint a character of greatness on all that he says. He must at the same time represent things with an air of gravity and prudence, and not give a loose to the heat of imagination, or vivacity of wit; but discreetly suppress every thing that shall seem idle, languid and unprofitable, and give every thing that just figure and proportion which is consistent with propriety and decorum. He must endeavour at a noble simplicity of thought, language, design, and ordinance, and carefully avoid all profuseness of false conceit, strained expression, and affected pompousness so inconsistent with the gravity, dignity, and noble character of history. In a word, he must write so as to be intelligible to the ignorant, and yet charm the wise; form and express such ideas as are great, and yet shall appear very common, and intermix no other ornament with his narration than what the modesty of truth can bear. He should be above the reach and power of hopes and fears, and all kinds of interest, that he may always dare to speak the truth, and write of all without prejudice; religiously observing never to abuse the public faith, nor to advance any thing upon common fame, which is always uncertain, but upon undoubted memoirs and faithful relations of such persons as have had a hand in affairs. He must always be upon his guard against the bias and affections of those who supply him with matter, and must not credulously give his assent to the historians that went before him, without enquiring narrowly into their character, and what influence they may have been under when they wrote, in order to make a just estimate of their weight and credit.

An historian, as to his matter, should choose subjects great in themselves, and such as are worthy of public fame and remembrance; and should make himself so far master of his matter, as to be able to cast it into what form he pleases, and to strike upon all his subjects the colours they are naturally disposed to bear, in order to make his lessons profitable to posterity, by regulating the heart and spirits of men, animating them to great and virtuous actions by illustrious examples, and cautioning them against vice, folly, cruelty, and injustice, by laying open the fatal consequences resulting from them. The course of his narration must proceed in the order of time in which the facts happened, in a pure, grave, uninterrupted series, such as may not improperly be compared to a great river flowing with composed majesty and stately smoothness; and when it falls in his way to introduce little occurrences, they must be so artfully interwoven with the great, in the thread of the narration, as to offer a seasonable entertainment and relief to the reader from the fatigue that too sedulous an attention to the great requireth.

He must also observe great judgment in the ordinance and disposition of events and their circumstances, so as to interest the reader, and let him into all his thoughts and views, by making his persons act as their character and temper inclined them; discovering their manners, sentiments, designs, motives, and operations, as they really stand in a necessary dependence upon each other, and with so natural a connection, as to show nothing out of its place. His transitions, in which consists the great art of narration, and one of its principal beauties, must be natural and easy, arising from the difference of subject rather than expression. He must make a wise and judicious choice of circumstances, such as are proper to enlarge and improve the ideas of things, and to strike that light and colour upon them which most easily attracts belief and engages the mind; and must for that purpose always observe a due mixture of great and little circumstances, neither of which must be carried beyond nature, or be so minute, low, or frivolous, as to debase his subject. He must not only recite the bare events and actions of men, but also lay open the motives and principles from which they took their rise, and upon which they proceeded to their final issues. He must lay open the hearts of the actors, let his reader into the most important secrets of their councils and designs, and oblige him with a sight of those secret springs which moved them to enterprizes, and of the causes of their success or miscarriage. He must be very sparing and cautious in the use of descriptions, which are to be introduced so far only as they serve to illustrate things that are essential to the main subject, and to enliven the narration: and even in that case they must be succinct and elegant. The frequent use of harangues are disapproved of by many judicious persons; for these long formal harangues of generals to their soldiers, when in the presence of the enemy, and ready to enter upon action, which we find in many historians, are undoubtedly not only unnatural and improbable, but contrary to the truth of history. Nevertheless, a short speech suited to the subject, made by a person of eminent character, has it proper beauty, and animates a narration. A judicious historian ought not to admit any portraits into his work but those of the greatest persons, and such as are principally interested, and have the chief hand in affairs; and these must be real, natural, and truly resembling their originals; expressive of their genius, the qualities of the head and heart, rather than descriptive of the external form of his personages. When such are finished with a masterly hand, with true judgment and success, they are not only great ornaments and embellishments in history, but of use to strip the hearts of men of their disguises, to lay open all their secret folds, and disclose the real springs of actions. It is a great fault in an historiographer to abound too much in reflections of his own; he therefore must not turn philosopher or moralist indifferently upon all occasions; for every man desires to be free in his judgment of the facts represented to him, and the consequences he is to draw from them, in which consists the greatest pleasure of the reader. But if an author should throw in, or mingle reflections of his own with his story, they must be such as arise naturally from the subject, and contain a great and noble sense in a few words; they must not be too fine spun or studied, nor have more brightness than solidity, but appear rather to be the reasoning of a wise statesman than the affectation of a declaimer; nor must they be too frequent, or too loose and disjointed, but be enamelled in the body of the work. Digressions, if made with judgment, and not too wide and foreign from the subject, have also their proper grace and ornament in history; as they give an agreeable variety to the narration, and relieve the mind of the reader; but they must be introduced by the historian with an artful hand and great address; they must bear an alliance and connection with the purport of the history, and their length must be proportionably greater or less, as they are more nearly or remotely allied to the capital point of the story.

HISTORY is a connected recital of past or present events.

If the value of each department of knowledge is to be ascertained by the esteem in which it is held by the generality of readers, a place of distinguished honour must be assigned to history. Gratifying that curiosity, which is innate in the mind of man, it is equally delightful to those whose intellect is just dawning, and to those whose faculties are matured by the lapse of time and the process of cultivation. Comparatively few have a relish for abstract speculations; but almost all are delighted by the display of facts. By the pictures, which are exhibited in a faithful narration the fancy is gently excited, and

the feelings are interested without being agitated to a degree inconsistent with pleasure. If then we consider history only as a source of elegant amusement, it is an object of no inconsiderable importance, in a course of liberal education.

But this is in fact the lowest commendation to which history is entitled. It is eminently productive of signal utility. The poet has justly remarked that, " the proper study of mankind is man;" and it is the office of history to trace the progress of man from the savage state, and through the intermediate degrees of civilization, to the nearest approach to perfection of which social institutions are capable. It falls within its province to note the effects of laws and political regulations, and to record the wondrous revolutions which have been produced in states by external violence, and the no less astonishing changes which have been occasioned by the gradual corruption of ancient systems of government. The record of past transactions, when diligently and minutely examined, will present to the politician matter of warning and matter of instruction. It will point out the sources of the errors of former days, and will also lead him to a discernment of the means which have crowned with success such plans as have been productive of benefit to the public. Knowledge which it thus gained is obtained at the cheapest possible price. Happy are the directors of political affairs, who learn in the philosophy of history, those lessons which their predecessors have learnt by the process of painful experience. It has been well observed by Voltaire, that the history of the sanguinary Christiern will deter those whose influence may happen to sway the destiny of nations, from investing a tyrant with absolute power; and that the disaster of Charles XII. before Pultowa affords a lesson of admonition to a general not to penetrate without provision into a country like the Ukraine; whilst the powerful and popular administration of Elizabeth of England, demonstrates the mighty effects of extended commerce and prudent œconomy. In a political point of view the general influence of historical knowledge is, indeed, of the highest importance, it tends to prevent the recurrence, and to diminish the remaining influence of superstition and religious persecution, and of the long train of calamities with which those direst enemies of human happiness are accompanied. For who can read the memorials of the papal usurpations in the dark ages, and of the melancholy consequences by which they were followed, without imbibing a spirit of tolerance, and a determined disposition to discountenance any claims which may revive the unjust assumptions of inordinate spiritual power. In short, history, whilst it details the miseries and misfortunes which have upon various occasions befallen civilized man, instructs him how those miseries and misfortunes may hereafter be avoided.

In a moral point of view history is extremely useful, as it points out the issues of things, and exhibits as its general result, the reprobation consequent upon vice, and the glory which awaits virtue. In his days of nature, the oppressor may be applauded by the venal, whilst he lords it over his fellow men, and the wanton destroyer of the human race may be hailed as a hero by the obsequious or mistaken crowd. But when his dust is mingled with that of the victims of his cruelty and ambition, history summons him to her tribunal: she scrutinizes his deeds with impartial strictness, and passes sentence upon him according to his deserts. The prejudices and errors of time present will hereafter be done away and corrected by history, which redresses the wrongs of the injured, and treats with just contempt the insolent assumption of the undeserving. Thus, by the record of crimes no less than by the display of illustrious examples of virtue, does history inculcate good principles, and enforce upon the reflecting mind a belief in a superintending providence.

The early annals of all countries are considerably debased by an intermixture of fables. In fact the first historians were universally poets, whose metaphors, amplifications, and allegories necessarily observed facts, or heightened them beyond the standard of probability. To explain their legends is the province of the mythologist, whose labours, however curious and interesting to those who have time and inclination for such pursuits, afford very little assistance to the historian.

But, the mythologic age, being thus consigned to the examination of those whom they may concern, however rude may be the style of ancient chronicles, or however simple and puerile the observations and reflections with which they may be interspersed, he who wishes to imbibe the true spirit of history will diligently peruse them, when they become the repositories of facts.

Such documents alone will give him an idea of the genius of the times concerning which they treat. He who wishes to become acquainted with the principles and manners which predominated in France in the reign of St. Louis or of John, will read the lively and simple, but minutely particular narratives of Joinville and of Froissart, rather than the dull details of a Daniel, or the hasty and imperfect sketch of a Millot. In all cases, indeed, he who wishes to see past events in their true light will refer as much as possible to original authorities. The farther the stream of history flows from its source, the more it is polluted by foreign mixtures. And besides this, however skilful, or however faithful, a compiler may be, his particular views lead him to pass unnoticed a variety of facts which are in themselves valuable, and indeed necessary to the perfect understanding of the real nature and bearings of events.

This maxim of having recourse to authentic documents will furnish a canon for the most profitable mode of studying ancient history. It will instruct the student to pass lightly over those periods of the Greek and Roman annals, the transactions of which were handed down by tradition to authors, who, instead of scrutinizing their credibility, have amplified and embellished them by the charms of style; and to direct his attention to the records which have been written by those who lived at the time when the actions which they commemorate took place, and more especially to the memoirs of illustrious warriors and statesmen who have left behind them the detail of transactions in which they have been personally concerned. Guided by this principle, he will not dwell upon the marvellous tales of an Herodotus or a Quintus Curtius; but he will study with diligence the narratives of a Thucydides or a Xenophon, of a Sallust, a Cicero, a Cæsar, or a Tacitus; and whilst the legend of Curtius, as recorded by Livy, only demonstrates to him the posthumous glory which, in the happier times of the Roman republic, awaited him who was ready to sacrifice his life for the good of his country, he will peruse, with more interest, the later periods of that writer's history, in which he treats of events which happened nearer to his own time, and the genuine records of which were, in all probability, furnished to him by the public offices of the state.

In regard to the earlier periods of modern history, authentic documents are scanty and obscure, and the investigator of the truth of facts is frequently obliged, as it were, to proceed with cautious steps through a dark and doubtful way; but, in process of time, they multiply to such an extent, that the student is embarrassed by their number. The archives of the different states of Europe, contain vast masses of materials, which occasional liberality has opened to the curious enquirer. On the important topic of ecclesiastical proceedings, the printed reports of the decrees of councils and synods throw the most satisfactory light. Voluminous collections of treatises, which have been compiled for the benefit of after times, open the policy of different states and empires; and in various cases, those documents are themselves illustrated by the comments and memoirs of the negociators by whom they were discussed and finally arranged. The confidential correspondence which took place between scholars, at the revival of letters, frequently contains political details which are highly instructive and interesting. In later days, the publication of the various memoirs and state-papers of ministers, to whom the conduct of the affairs of nations has been entrusted, reveal all the springs of their policy, and enable the reader of research to follow them through all the windings of the labyrinth of intrigue. The acts of the British parliament, in themselves, contain a record of the political changes which have taken place in this country, of our progress in commerce, of the gradual amelioration of our constitution, amidst the struggles of party and the contentions of faction. The recorded proceedings of our courts of law, also supply the means of judging of the public conduct of our statesmen. It may be with truth asserted, that the perusal of the state trials can alone give an adequate idea of the horrible crimes which, under the colour of justice, were perpetrated by the different parties which divided this kingdom in the reign of Charles II. In short, there hardly exists in any country a public office, or a private collection of papers, which does not contain documents that are calculated to throw light upon history.

The student who wishes to pursue his historical enquiries with becoming accuracy, must make himself master of the details of geography, and of the principles of statistical calculations, must moreover be versed in all the minutiæ of chronological researches. In the settling of dates, he will at once evince his labour and his ingenuity.

For the correct arrangement of the order of events, he will not shrink from the task of poring over pedigrees, or examining coins.

It has been well observed, by the profound Pinkerton, that by the study of medals alone, Vaillant "was enabled to ascertain, in a very great degree, the chronology of three important kingdoms of the ancient world, namely, those of Egypt, of Syria, and of Parthia."

Such are the principal sources from which may be derived a knowledge of historic truth. To enumerate all the materials of history would be an almost endless task; but in order to make due profit of these materials, wherever they may occur, the student ought to be animated by the spirit of philosophical enquiry. "Incredulity," says Aristotle, "is the foundation of all wisdom." Without the gift of discrimination the historian degenerates into a chronicler of fables; without the faculty of deducing useful consequences, he is degraded into a registrar of barren facts. To distinguish truth from falshood in the obscure records of former times, or amidst the misrepresentations of factious malignity in more modern periods, requires no small degree of sagacity. Voltaire has justly observed, that in order to be qualified to seize the proper objects of history, a man must not be acquainted with books alone. He must have a minute knowledge of the human heart, and be qualified to analyze the prejudices and the passions of men. He will give due weight to circumstances and situations. He will not estimate the character of a despot by the panegyric of a courtier; nor will he pass sentence of condemnation on a prince who has resisted ecclesiastical claims and restrained the power of the clergy, because he is vilified in the chronicles of a monk.

The enlightened student of history will not direct his chief attention to the frivolous anecdotes of a court, but to the circumstances which stamp the character and decide the destiny of a nation. He will enquire what has been its radical vice or its predominant virtue; why it has been powerful or weak by sea or land; what has been the improvement or the deterioration of its trade and commerce; wherein consist the excellencies and the defects of its civil and municipal institutions; what have been the constitution, and what the influence of its ecclesiastical establishments. He will trace the introduction of arts and manufactures, and observe the changes which have taken place in manners and in laws.

Such are the materials and such the objects of history, than which next to our relation to the deity, no more important topic of enquiry can be presented to the human intellect.

HITCH, in the sea language, is to catch hold of any thing with a hook or rope, and by this means to hold it fast: thus when a boat is to be hoisted in, the sailors say, "Hitch the tackles into the ring bolts of the boat;" and when they are about to weigh anchor, "Hitch the fish-hook to the fluke of the anchor."

HIVE, in country affairs, a convenient receptacle for bees. See BEE.

HOD, an instrument used to carry bricks and mortar in, up ladders, &c. to build or repair houses, &c. with.

HODMAN, an appellation given to a young student admitted into Christ's College in Oxford, from Westminster school.

HOE, in country affairs, a tool made like a cooper's adze, to cut upwards in gardens, fields, &c. This tool is commonly called the hand-hoe.

HOFFMANNIA, in botany, so named in memory of Maurice Hoffman, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx four-toothed; corolla salver-shaped, four-parted; filaments none; berry two-celled, many-seeded. There is only one species, *viz*, H. pedunculata, a native of Jamaica.

HOG. See SUS.

HOG, *hedge*. See ERINACEUS.

HOKE *day*, the Tuesday after Easter week, which was the day on which the English conquered and expelled the Danes; this was therefore kept as a day of rejoicing, and a duty, called Hoke Tuesday money, was paid to the landlord, for giving his tenants and bondmen leave to celebrate it.

HOLCUS, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Gramina or Grasses. Essential character: hermaphrodite, calyx glume, one or two-flowered; corolla glume, awned; stamina three; styles two; seed one: male, calyx glume, two-valved; corolla none; stamina three. There are fifteen species.

HOLD, that part of a ship which lies between the keelson and the lower deck; in which, divided by bulk heads, are the steward's-room, powder-room, bread-room, and the boatswain's and carpenter's store-rooms. In a merchantman, all the goods and lading in general, are stowed in the hold.

HOLD *fast*, a large piece of iron, in the shape of the letter S, fixed into a wall to strengthen it. Also a tool used by joiners, carvers, &c. which goes through their benches to hold fast such work as cannot be finished by its being held in the hand.

HOLLAND, in commerce, a fine and close kind of linen, so called from its being first manufactured in Holland.

HOLLOA, in sea language, an exclamation of answer to any person who calls to another to ask some question, or to give a particular order: thus, when the master means to give any order to the people in the main-top, he previously calls "Main-top hoay," to which they answer, "Holloa," to shew that they hear him and are ready. It is also the answer in hailing a ship at a distance. See HAILING.

HOLLOW *square*, in the military art, a body of foot drawn up, with an empty space in the middle for colours, drums, and baggage.

HOLLY. See ILEX.

HOLOMETER, a mathematical instrument that serves universally for taking all measures, both on the earth and in the heavens.

HOLORACEÆ, in botany, the name of the twelfth order in Linnæus's "Fragments of a Natural Method," consisting of pot herbs, or plants used for the table, and entering into the economy of domestic affairs. This order is separated into two divisions. 1. Hermaphrodite plants. 2. Male, female, androgynous, and polygamous plants. This order contains trees, shrubs, and perennial and annual herbs; some of the woody vegetables, as the bay, retain their green leaves during the winter; the roots are long; the stems and young branches are cylindric. In the greatest part of the aquatic plants of this order, the stalks are hollow within; the buds are of a conical form; the leaves are generally simple, alternate, entire, and attached to the branches by a cylindric footstalk, which is sometimes very long, but generally short.

HOLOSTEUM, in botany, a genus of the Triandria Trigynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; petals five; capsule one-celled, subcylindrical, opening at top. There are five species.

HOLOTHURIA, in natural history, a genus of the Vermes Mollusca class and order. Body detached, cylindrical, thick, naked, and open at the extremity; mouth surrounded by fleshy branched tentacula or feelers. These are all inhabitants of the sea, and expand or contract themselves at pleasure; the anterior aperture serves them both as a mouth and vent, and from the hinder one they reject waters which had been previously drawn in; the tentacula are retractile. There are twenty-three species. H. pentactes, or five-rowed Holothuria, is noticed by Pennant. It has an incurvated cylindric body, marked with longitudinal rows of papillæ; out of the centre of each issue, at pleasure, slender feelers like the horns of snails; the upper extremity retractile; when exerted it assumes a cordated form, surrounded at the apex with eight tentacula, elegantly ramified, of a yellow and silver colour. It is found on the shores near Penzance. H. tremula is a foot long, inhabits the Mediterranean and Adriatic seas; the body is cylindrical when extended, and oblong when contracted; it is various in colour, but generally of a beautiful mixture of red and white; the cylindrical tubes beneath the body act as so many suckers, by which the animal fixes itself firmly to the bottom of the sea. Another curious species noticed by Gmelin is H. denudata, is oblong, with interrupted lateral lines, and without a crest or tail, inhabits the American ocean. It is three or four inches long, with a body slowly tapering at both ends, transparent, of a firm gelatinous consistence and hollow, opening by a small triangular aperture next the crest, and a narrow round one at the other extremity; they have a spiral milky line down the back, under this another larger opaque one, and on each side below these another smaller purple one. They are sometimes found single, and frequently sticking lengthways together. The word holothuria is used by Pliny and Aristotle; but Mr. Pennant supposes they both intended, under this name, to describe those marine bodies now denominated zoophyta. Aristotle, however, seems to have admitted that they possessed animal life, a circumstance that has in modern times been completely ascertained.

HOMALIUM, in botany, a genus of the Polyandria Trigynia class and order. Natural order of Rosaceæ, Jussieu. Essential character: calyx six or seven parted; corolla six or seven petalled; stamens twenty-one, in three bodies; pericarpium one-celled, many-seeded. There are two species.

HOMER, OMER, CORUS, or CHOMER, in Jewish antiquities, a measure containing

ten baths, or seventy-five gallons and five pints, as a measure for things liquid; and thirty-two pecks and one pint, as a measure for things dry. The homer was most commonly a measure for things dry, and the greatest that was used among the Jews: it contained, according to the Rabbins, ten ephaps, or thirty fata or seahs. Corus is the most usual term in the historical writers, and homer, omer, or chomer, among the prophets.

HOMICIDE, in law, is the killing of a man by a man. Of this there are several species, as homicide by self-defence, homicide by misadventure, justifiable homicide, manslaughter, chance-medley, and murder. Homicide by self-defence, *se defendendo*, or in a man's own defence, is where one has no other possible means of preserving his life from one who combats with him on a sudden quarrel, and kills the person by whom he is reduced to such inevitable necessity. And not only he who on an assault retreats to a wall, or some such strait, beyond which he can go no farther, before he kills the other, is judged by the law to act upon unavoidable necessity; but also he, who being assaulted in such a manner, and in such a place, that he cannot go back without manifestly endangering his life, kills the other, without retreating at all. And though a person who retreats from an assault to the wall, should give the other wounds in his retreat, yet if he give him no mortal wound till he get thither, and then kill him, he is guilty of homicide *se defendendo* only. But if the mortal wound were given first, then it is manslaughter.

Homicide by misadventure, is where a man in doing a lawful act, without any intent of hurt, unfortunately chances to kill another; as where a labourer being at work with an hatchet, the head thereof flies off, and kills one who stands by. It seems clear, that neither homicide by misadventure, nor homicide *se defendendo*, are felonious, because they are not accompanied with a felonious intent, which is necessary in every felony.

HOMICIDE, *justifiable*. To make homicide justifiable, it must be owing to some unavoidable necessity, to which a person who kills another must be reduced, without any manner of fault in himself. And there must be no malice coloured under pretence of necessity; for wherever a person who kills another, acts in truth upon malice, and takes occasion upon the appearance of necessity to execute his own private revenge, he is guilty of murder. But if a woman kill him who assaulteth to ravish her, it is no felony: or if a man come to burn my house, and I go out and kill him, it is no felony. So, "if any evil-disposed person, shall attempt feloniously to rob or murder any person in any dwelling-house, or highway, or feloniously attempt to break any dwelling-house in the night-time, and shall happen to be slain in such felonious attempt, the slayer shall be discharged, and shall forfeit no lands nor goods." 24 Henry VIII. c. 5. Justifiable homicide of a public nature, is such as is occasioned by the due execution or advancement of public justice, with regard to which it must be observed, 1. That the judgment, by virtue whereof any person is put to death, must be given by one who has jurisdiction in the cause; for otherwise both judge and officer may be guilty of felony. 2. The execution must be pursuant to, and warranted by the judgment, otherwise it is without authority; and consequently, if a sheriff shall behead a man, when it is no part of the sentence to cut off the head, he is guilty of felony.

HOMICIDE, *manslaughter*, against the life of another, is either with or without malice; that which is without malice is called manslaughter, or sometimes chance-medley, or chaud-medley, by which is understood such killing as happens either on a sudden quarrel, or in the commission of an unlawful act, without any deliberate intention of doing any mischief at all. Hence it follows, that there can be no accessaries to this offence before the fact, because it must be done without premeditation; but there may be accessaries after the fact. The only difference between murder and manslaughter, is, that murder is upon malice aforethought, and manslaughter upon a sudden occasion, as if two meet together, and striving for the wall, the one kills the other, this is manslaughter and felony. And if they had, on that sudden occasion, gone into the field and fought, and the one had killed the other, this had been but manslaughter, and no murder; because all that followed was but a continuance of the first sudden occasion, and the blood was never cooled till the blow was given.

Chance, or chaud-medley. Authors of the first authority disagree about the application of this word. By some it is applied to homicide by misadventure, by others to manslaughter. The original meaning of the word seems to favour the former opinion, as

it signifies a sudden or casual meddling or contention; but homicide by misadventure supposes no previous meddling or falling out.

Murder is the highest crime against the law of nature, that a man is capable of committing. It is when a man of sound memory, and at the age of discretion, unlawfully kills another person under the King's peace with malice aforethought, either expressed by the party, or implied by the law, so as the party wounded or hurt, die of the wound or hurt within a year and a day, the whole day on which the hurt was done, being reckoned the first.

By malice express, is meant a deliberate intention of doing any bodily harm to another, to do which, by law, a person is not authorized. And the evidences of such malice, must arise from external circumstances discovering that inward intention; as lying in wait, menacings, antecedent, former grudges, deliberate compassings, and the like, which are various, according to the variety of circumstances. Malice implied, is where a person voluntarily kills another, without any provocation. For in this case the law presumes the act to be malicious.

If a man kill another, it should be intended, *prima facie,* that he did it maliciously, unless he can make the contrary appear, by shewing that he did it on a sudden provocation or the like. And when the law makes use of the term malice aforethought, as descriptive of the crime of murder, it must not be understood in that narrow restrained sense, to which the modern use of the word malice is apt to lead one, a principle of malevolence to particulars; for the law by the term malice, in this instance means, that the fact has been attended with such circumstances, as are the ordinary symptoms of a wicked heart, regardless of social duty, and fatally bent upon mischief.

The law so far abhors all duelling in cold blood, that not only the principal who actually kills the other, but also his seconds are guilty of murder, whether they fought or not; and it is holden that the seconds of the person killed, are also equally guilty, in respect to the countenance which they give to their principals in the execution of their purpose, by accompanying them therein, and being ready to bear a part with them. Also it seems agreed, that no breach of a man's word or promise, no trespass either to land or goods, no affront by bare words or gestures, however false or malicious it may be, and aggravated with the most provoking circumstances, will excuse him from being guilty of murder, who is so far transported thereby, as immediately to attack the person who offends, in such a manner as manifestly endangers his life, without giving him time to put himself upon his guard, if he kill him in pursuance of such assault, whether the person slain did at all fight in his defence or not.

HOMINE *replegiando,* a writ to bail a man out of prison, now disused on account of the superior advantage of the habeas corpus.

HOMO, *man,* in natural history is ranked by Linnæus under the order Primates, which is characterized by having four cutting teeth in the upper and lower jaw, and two mammæ in the breast. There are two species, 1. H. sapiens, including six varieties, *viz.* the wildman, four-footed, mute, hairy. 2. American, copper-coloured, choleric, erect. 3. European, fair, sanguine, brawny. 4. Asiatic, sooty, melancholy, rigid. 5. African, black, phlegmatic, relaxed. II. H. monstrosus, including, 1. The mountaineer, small, active, timid. 2. Patagonian, large, indolent. 3. Hottentot, less fertile. 4. American, beardless. 5. Chinese, head conic. 6. Canadian, head flattened. See MAN.

HOMOGENEOUS, or HOMEGENEAL, an appellation given to things, the parts of which are similar or of the same nature and properties.

HOMOGENEOUS *light,* that whose rays are all of one colour and degree of refrangibility, without any mixture of others. See the article COLOUR.

HOMOGENEOUS *surds,* those which have the same radical character, or signs, as $\sqrt[2]{a}$, and $\sqrt[2]{b}$. See the article SURD.

HOMOLOGOUS, in geometry, an appellation given to the corresponding sides and angles of similar figures, as being proportional to each other.

All similar figures have their like sides homologous, or proportional to one another: their areas also are homologous, or proportional to the squares of the like sides, and their solid contents are homologous or proportional to the cubes of the same.

HONE, a fine kind of whetstone, used for setting razors, pen-knives; and the like.

HONEY, a vegetable product, very similar in its properties to sugar. It is found in large quantities in a number of vegetables, is collected by the bee, and is fed upon by many insects. It is always formed in the flower, chiefly at the base of the

pistil, and it seems designed to receive and retain the fecundating pollen. Honey differs much in colour and in consistence; it contains much saccharine matter, and probably some mucilage, from which it derives its softness and viscosity. Honey very readily enters into the vinous fermentation, and yields a strong liquor called mead. There are two species of honey, the one is yellow, transparent, and of the consistence of turpentine; the other white, and capable of assuming a solid form, and of concreting into regular spheres. These two species are often united, they may be separated by means of alcohol, which dissolves the liquid honey much more readily than the solid. Honey has never been accurately analyzed, but some late experiments go to prove it is composed of sugar, mucilage, and an acid.

In France, a good swarm of bees, in two years, will yield near thirty pounds of honey; and they are still more profitable in countries that are covered with flowers the greatest part of the year. There are two sorts of honey, the white and the yellow. The white or virgin honey, trickles out spontaneously from the combs. These they break, soon after they are made, and lay them upon hurdles or mats of osier, or on linen cloth, fastened at the four corners to as many posts, and then an excellent white honey will fall from the combs, and grow hard in a short time. Afterwards they put it into glazed earthen pots. Some press this honey out, but then it is not so agreeable, for it will taste of the wax. The best sort of French virgin honey, is that of Languedoc, called honey of Narbonne. It should be new, thick, granulated, of a clear transparent white colour, of a soft and somewhat aromatic smell, and of a sweet and lively taste. If it is very pure, it is almost as hard as sugar-candy; and what renders it so superior, are the many aromatic flowers which grow in those parts, and from which the bees gather their honey. It is always observable, that the honey made in mountainous countries, is more highly flavoured than that of low grounds. The honey made in the spring, is more esteemed, than that gathered in the summer; that of the summer more than that of the autumn. There is also a preference given to that of young swarms. Yellow honey is obtained by pressure, from all sorts of honey-combs, old as well as new; and even of those from whence the virgin honey has been extracted. They break the combs, and heat them with a little water in basons or pots, keeping them continually stirring; then they put them into bags of thin linen cloth, and these they put in a press, to squeeze out the honey. The wax stays behind in the bag, though always some small particles of it pass through with the honey. Honey is the production of most countries; yet more abundant in the island of Candia, and in the greater part of the islands of the Archipelago, than any where else. The Sicilian honey seems to be particularly high flavoured, and in some parts of the island, even to surpass that of Minorca: which no doubt is owing to the quantity of aromatic plants with which that country is overspread. This honey is gathered three times in the year, in July, August, and October. It is found by the peasants in the hollow of trees and rocks. The country of the lesser Hybla is still, as formerly, the part of the island that is most celebrated for this article. Considerable quantities of honey are produced by the wild bees in the woods of North America.

Honey *comb*, a waxen structure, full of cells, framed by the bees, to deposit their honey and eggs in. The construction of the honey-comb seems one of the most surprising parts of the works of insects, and the materials of which it is composed, which, though evidently collected from the flowers of plants, yet do not, that we know of, exist in them in that form, has given great cause of speculation to the curious. The regular structure of the comb is also equally wonderful. When the several cells in it are examined, it should seem that the nicest rules of geometry had been consulted for its composition, and all the advantages that could be wished or desired in a thing of that kind, are evidently found in it. Each cell consists of six plane sides, which are all trapeziums, but equal to each other: the bottom of the cell is contrived with three rhombuses, so disposed as to constitute a solid angle under three equal angles, and each of which is double the maximum angle of 54° 44′. Hence it comes to pass, that a less quantity of surface is sufficient to contain a given quantity of honey, than if the bottom had been flat, in the proportion of 4,658 to 5,550, as has been found by calculation; that is, nearly a fifth of the whole, so far as the figure in the end of the cells extends, in each; which fifth part of wax and labour saved, amounts to a vast deal in the whole comb. And if these admirable insects knew their advantage, they could not

more nicely observe the rules of modern geometry.

The method of making two sorts of cells in each comb, is also admirably contrived to save the expence of wax, since had they been made single, every comb must have had its peculiar base, and every set of cells their bottom of wax, whereas one bottom now serves for two cells; and there is but one plate of wax in the centre of a double comb. This structure occasions a very great sparing of the wax, or matter of the comb; but, besides this, there is another great advantage resulting from this structure, which is, that the angles arising from the forementioned combination of the bases, greatly strengthen the whole work.

The sides of the cells are all much thinner than the finest paper, and yet they are so strengthened by their disposition, that they are able to resist all the motions of the bee within them, as they are frequently obliged to be. The effect of their thrusting their bodies into the cells, would be the bursting of those cells at the top, were not this well guarded against. But to prevent this, the creatures extend a cord, or roll of wax, round the verge of every cell, in such a manner, that it is scarce possible they should split in that particular part. This cord or roll is at least three times as thick as the sides of the cell, and is even much thicker and stronger at the angles of the cells, than elsewhere, so that the aperture of each cell is not regularly hexagonal, though its inner cavity be perfectly so. The several combs are all placed parallel to one another, and there is such a space left between them, that the bees can easily pass; and often they place a part of the comb in a contrary direction to the rest, so that while the others are placed horizontally, these stand perpendicularly. The cells which have served, or are to serve for the habitation of the worms of the common and of the male bees, are often made also at other times the receptacles of honey; but though these are indifferently made to serve either use, there are others destined only to receive honey. The celerity with which a swarm of bees, received into a hive where they find themselves lodged to their minds, bring their works of the combs to perfection, is amazing. There are vast numbers at work all at once; and that they may not incommode one another, they do not work upon the first comb till it is finished, but when the foundation of that is laid, they go to work upon another, so that there are often the beginnings of three or four stories made at once, and so many swarms allotted to the carrying on the work of each.

HONEY *stone.* See MELLITE.

HONOUR, in law, is used especially for the more noble sort of seigniories on which other inferior lordships or manors depend, by performance of some customs or services to those who are lords of them. Before the statute 18 Edward I. the king's greater barons, who had a large extent of territory holden under the crown, frequently granted out smaller manors to inferior persons to be holden of themselves; which therefore now continue to be held under a superior lord; who is called in such cases the lord paramount over all these manors; and his seigniory is frequently termed an honour, not a manor, especially if it has belonged to an ancient feudal baron, or been at any time in the hands of the crown. When the King grants an honour with appurtenances, it is superior to a manor with appurtenances; for to an honour, by common intendment, appertain franchises, and by reason of those liberties and franchises, it is called an honour.

HONOUR, *courts of.* There is a court of honour of earl marshal of England, &c. which determines disputes concerning precedency and points of honour.

HONOURS, *military;* all armies salute crowned heads in the most respectful manner, colours and standards dropping, and officers saluting. Different ranks of officers are saluted in a different mode.

HONOURS *of war,* are stipulated terms which are granted to a vanquished enemy, and by which he is permitted to march out of a town, from a camp, or line of entrenchments, with all the insignia of military etiquette. In another sense, they signify the compliments which are paid to great personages, military characters, when they appear before an armed body of men, or such as are given to the remains of a deceased officer. The particular circumstances attending the latter, depend greatly upon the usages of different countries.

HOOK, a piece of iron or brass wire bent, and turned up at one end.

HOOK *pins,* are bolts made with a shoulder at one end, and used by carpenters in framing: these are drove through the mortices and tenants of the work prepared for building or wharfing.

HOOPOE, *upupa,* in ornithology. See UPUPA.

HOPEA, in botany, so named in honour of Dr. Hope, professor of botany at Edinburgh, a genus of the Polyadelphia Polyandria class and order. Natural order of Guaiacanæ, Jussieu. Essential character: calyx five-cleft, superior; corolla five-petalled; stamens many, connected in five bodies; style one; drupe with a three-celled nut. There is only one species, *viz.* H. tinctoria, a native of Carolina.

HOP, in botany. See HUMULUS. Hops are said to have been first brought into England from the Netherlands, in the year 1524. They are first mentioned in the English statute-book in the year 1552, *viz.* in the 5th and 6th Edw. VI. cap. 5, and by an act of parliament of the first year of King James I. anno 1603, cap. 18, it appears that hops were then produced in abundance in England. The hop being a plant of great importance in this country, we shall briefly consider what relates to the culture and management of it under distinct heads. As for the choice of soil, the hop-planters esteem the richest and strongest ground the most proper; and if it is rocky within two or three feet of the surface, the hops will prosper well; but they will by no means thrive on a stiff clay or spongy wet land. Hops require to be planted in a situation so open as that the air may freely pass round and between them, to dry up and dissipate the moisture, whereby they will not be so subject to fire-blasts, which often destroy the middle of large plantations, while the outsides remain unhurt. The hills should be eight or nine feet asunder, that the air may freely pass between them. If the ground is intended to be ploughed with horses between the hills, it will be best to plant them in squares, chequerwise; but if the ground is so small that it may be done with the breast-plough or spade, the holes should be ranged in a quincunx form. Which way soever you make use of, a stake should be stuck down at all the places where the hills are to be made. Persons ought to be very curious in the choice of the plants as to the kind of hop; for if the hop-garden is planted with a mixture of several sorts of hops that ripen at several times, it will cause a great deal of trouble, and be a great detriment to the owner.

The two best sorts are the white and the grey bind; the latter is a large square hop, more hardy, and is the more plentiful bearer, and ripens later than the former. There is another sort of the white bind, which ripens a week or ten days before the common; but this is tenderer and a less plentiful bearer, but it has this advantage, that it comes first to market. If there is a sort of hop you value, and would increase plants and sets from, the superfluous binds may be laid down when the hops are tied, cutting off the tops, and burying them in the hill; or when the hops are dressed, all the cuttings may be saved, for almost every part will grow and become a good set the next spring. As to the manner of planting the sets, there should be five good sets planted in every hill, one in the middle, and the rest round about, sloping. Let them be pressed close with the hand, and covered with fine earth, and the stick should be placed on each side the hill to secure it. When the hop ground is dug in January or February, the earth about the hills, and very near them, ought to be taken away with a spade, that you may come the more conveniently at the stock to cut it. About the end of February, if the hops were planted the spring before, or if the ground is weak, they ought to be dressed in dry weather; but else, if the ground is strong and in perfection, the middle of March will be a good time; and the latter end of March, if it is apt to produce over rank binds, or the beginning of April, may be soon enough. Then having, with an iron picker, cleared away all the earth out of the hills, so as to clear the stock to the principal roots, with a sharp knife you must cut off all the shoots which grow up with the binds the last year; and also all the young suckers, that none be left to run in the alley, and weaken the hill. It will be proper to cut one part of the stock lower than the other, and also to cut that part low that was left highest the preceding year. In dressing those hops that have been planted the year before, you ought to cut off both the dead tops and the young suckers which have sprung up from the sets, and also to cover the stocks with fine earth, a finger's length in thickness. About the middle of April the hops are to be poled, when the shoots begin to sprout up; the poles must be set to the hills deep into the ground, with a square iron picker or crow, that they may the better endure the winds: three poles are sufficient for one hill. These should be placed as near the hill as may be, with their bending tops turned outwards from the hill to prevent the binds from entangling; and a space between two poles ought to be left open to the south to admit

the sun beams. As to the tying of hops, the buds that do not clasp of themselves to the nearest pole, when they are grown to three or four feet high, must be guided to it by the hand, turning them to the sun, whose course they will always follow. They must be bound with withered rushes, but not so close as to prevent them from climbing up the pole. This you must continue to do till all the poles are furnished with binds, of which two or three are enough for a pole, and all the sprouts and binds that you have no occasion for, are to be plucked up; but if the ground is young, then none of these useless binds should be plucked up, but should be wrapped up together in the middle of the hill. About the beginning of July the hops begin to blow, and will be ready to gather about Bartholomew tide. A judgment may be made of their ripeness by their strong scent, their hardness, and the brownish colour of their seed. When by these tokens they appear to be ripe, they must be picked with all the expedition possible; for if at this time a storm of wind should come, it would do them great damage by breaking the branches, and bruising and discolouring the hops; and it is well known that hops, being picked green and bright, will sell for a third more than those which are discoloured and brown.

The most convenient way of picking them is into a long square frame of wood, called a bin, with a cloth hanging on tenter hooks within it, to receive the hops as they are picked. The best method of drying hops is with charcoal on an oast, or kiln, covered with hair cloth, of the same form and fashion that is used for drying malt. The hops must be spread even upon the oast, a foot thick or more, if the depth of the curb will allow it; but care is to be taken not to over load the oast, if the hops are green or wet. The oast ought to be first warmed with a fire before the hops are laid on, and then an even steady fire must be kept under them; it must not be too fierce at first, lest it scorch the hops; nor must it be suffered to sink or slacken, but rather be increased till the hops are nearly dried, lest the moisture or sweat, which the fire has raised, fall back or discolour them. When they have lain about nine hours they must be turned, and in two or three hours more they may be taken off the oast. It may be known when they are well dried by the brittleness of the stalks, and the easy falling off of the hop leaves. As soon as the hops are taken off the kiln, lay them in a room for three weeks or a month to cool, give, and toughen; for if they are bagged immediately, they will powder, but if they lie a while (and the longer they lie the better, provided they are covered close with blankets to secure them from the air) they may be bagged with more safety, as not being liable to be broken to powder in treading; and this will make them bear treading the better, and the harder they are trodden, the better they will keep.

Hops, by several statutes, regulations are made for the curing of hops, &c. which are placed under the inspection of the officers of excise.

HOPPER, a kind of basket, wherein the seed-corn is carried at the time of sowing. It is also used for the wooden trough in a mill, into which the corn is put to be ground. See Mill.

HORARY, or Hour Circle *of a globe*, is a small brazen circle, fixed upon the brazen meridian, divided into twenty-four hours, having an index moveable round the axis of the globe, which, upon turning the globe fifteen degrees, will show what places have the sun an hour before or after us; for instance, if the index of the hour circle be set at the upper XII. when the globe is rectified for London, and the globe turned 15 degrees from east to west, the index will point at the hour of I. which shews that all places under that meridian, and particularly Naples, have the sun an hour sooner than London has it: on the contrary, let the index be set at the upper XII. again, and the globe be turned 15 degrees from west to east, the index will point at XI. because all places under that meridian, particularly the Madeira islands, have the sun an hour after London has it. For the several problems performable on the globes, by means of the horary circle, see Globes, *use of.*

Horary *circles*, or *lines*, in dialling, are the lines or circles which mark the hours on sun-dials. See Dialling.

Horary *motion of the earth*, the arch it describes in the space of an hour, which is nearly 15 degrees, though not accurately so, as the earth moves with different velocities, according to its greater or lesser distance from the sun. Hence we see the method of reducing motion into time, and *vice versa*; since $15^\circ = 60'$, or one hour, $1^\circ = 4'$: therefore the clocks at places 15° east of London are one hour faster than those at London; and the clocks at places 15° west of London are one hour later than those at London, and

so in proportion. Thus, if I wish to know what o'clock it is at Constantinople, and also at Boston in North America, now it is eight o'clock, A. M. here. I look to the gazetteer, and find Constantinople to be 29° east of London, and Boston is 70° 30′ west: to reduce these degrees to time, I divide each by 15, and I find $\frac{29}{15} = 1^h\ 56^m$, and $\frac{70^\circ\ 30'}{15} = 4^h\ 42^m$.; accordingly the time at Constantinople is $1^h\ 56^m$ before our time, and at Boston it is $4^h\ 42^m$ behind it: that is, at eight o'clock in London it will be 56 minutes after nine at Constantinople, and at Boston it will be only 18 minutes past three o'clock.

HORD, in geography, is used for a company of wandering people, which have no settled habitation, but stroll about, dwelling in waggons or under tents, to be ready to shift as soon as the herbage, fruit, and the present province is eaten bare; such are several tribes of the Tartars, particularly those who inhabit beyond the Wolga, in the kingdoms of Astracan and Bulgaria. A hord consists of fifty or sixty tents, ranged in a circle, leaving an open place in the middle. The inhabitants of each hord usually form a military company or troop, the eldest whereof is commonly the captain, and depends on the general or prince of the whole nation.

HORDEUM, in botany, *barley*, a genus of the Triandria Digynia class and order. Natural order of Grasses. Essential character: calyx lateral, two-valved, one-flowered, by threes, at each toothlet of the rachis. There are nine species.

HORIZON, in astronomy and geography, that great circle which divides the heavens and the earth into two equal parts, or hemispheres, distinguishing the upper from the lower. The horizon is either sensible or rational: the sensible horizon is that circle which, being discovered by our senses, limits our prospect.

When we are on terra firma, this circle commonly seems rugged and irregular, occasioned by the unevenness of the ground; but at sea, there are no such irregularities. The semi-diameter of this circle varieth according to the height of the eye of the observer. If a man, six feet high, stood upon a large plain, or the surface of the sea, he could not see quite three miles round. To find the distance to which a person can see, at any given height of the eye, or the extent of the visible horizon, is a problem of some utility, particularly to mariners: the rule is, "multiply the square root of the height of the eye in feet, by 1.225, and the product is the distance in miles, to which we can see from that height:" thus a sailor, standing at the top-mast of a ship 120 feet high, can see a distance in miles $= \sqrt{120} \times 1.225 = 13.45 =$ to 13 miles and a half nearly.

The rational, or true horizon, is a great circle of the apparent celestial sphere, dividing it into two equal hemispheres, and serving as the limits of elevation or depression of celestial objects. This horizon being parallel to the sensible horizon, is distant from it by the semi-diameter of the earth, through whose centre it passes: for the astronomers reduce the appearances of the heavens to a spherical surface, which is not concentrical to the eye, but to the earth. It divides the heaven and earth into two parts, the one light, and the other dark, which are greater or lesser, according to the condition of the place, &c. It determines the rising and setting of the sun, moon, or stars, in any particular latitude; for, when any of these appear just at the eastern part of the horizon, we say, it rises; and when it does so at the western part, we say, it sets. And from hence also the altitude of the sun or stars is accounted, which is their height above the horizon. This circle is divided by astronomers into four quadrants, or cardinal points. The poles of this horizon are the zenith and the nadir: and the innumerable circles drawn through these poles to the horizon, are called the vertical circles, or azimuths. These two horizons produced to the fixed stars, will appear to coincide into one, since the earth, compared to the sphere in which the fixed stars appear, is but a point; therefore the two circles, which are but a point distant from each other, may be well considered as coinciding into one.

HORIZON *of a globe*. See GLOBE.

HORIZONTAL, something relating to the horizon; or that is taken in, or on a level with the horizon: thus we say, an horizontal plane, &c.

It frequently happens at sea, that the atmosphere is so hazy as to prevent a distinct view of the horizon, which is a great hindrance to accurate observations. This inconvenience is remedied by an

HORIZONTAL *speculum*, which consists in a well-polished metal speculum, about three or four inches in diameter, inclosed within a rim of brass; so fitted, that the centre

of gravity of the whole shall fall near the point on which it turns. This is the end of a steel axis running through the centre of the speculum, above which it finishes in a square for the convenience of fitting a roller on it, by which it is set in motion by means of a piece of tape wound round the roller. The cup in which it turns is made of agate, flint, or other hard substance, and a cover to the whole may be made of glass; by this means an observation may be taken with it as well covered as open, which will prevent injury from the spray of the sea. These specula are as useful by night as by day; for as the images of the stars may be seen in the speculum, consequently any object that can be seen reflected from the glasses of the quadrants may be observed by the speculum, and these are all the stars of the first magnitude, the planets Venus, Mars, Jupiter, Saturn, and the moon; so that by having the declinations of these bodies in the Nautical Almanack, or indeed in any ephemeris, they may be used in observations as well as the sun.

Horizontal *dial*, that drawn on a plane parallel to the horizon, having its style elevated according to the altitude of the pole, in the place it is designed for. See Dial.

Horizontal *line*, in perspective, a right line drawn through the principal point parallel to the horizon; or it is in the intersection of the horizontal and perspective planes. See Perspective.

Horizontal *parallax*. See Parallax.

Horizontal *plane*, that which is parallel to the horizon of the place, or nothing inclined thereto. The business of levelling is to find whether two points be in the horizontal plane, or how much the deviation is.

Horizontal *plane*, in perspective, a plane parallel to the horizon passing through the eye, and cutting the perspective plane at right angles.

Horizontal *range*, of a piece of ordnance, is the distance at which a ball falls on, or strikes a horizontal plane, whatever be the angle of elevation or direction of the piece. When the piece is pointed parallel to the horizon, the range is then called the point-blank, or point-blanc range. The greatest horizontal range, in the parabolic theory, or in a vacuum, is that made with the piece elevated to 45 degrees, and is equal to double the height from which a heavy body must freely fall to acquire the velocity with which the shot is discharged. Thus, a shot being discharged with the velocity of v feet per second; because gravity generates the velocity $2g$, or $32\frac{1}{6}$ feet, in the first second of time, by falling $16\frac{1}{12}$, or g feet, and because the spaces descended are as the squares of the velocities, therefore as $4g^2 : v^2 :: g : \frac{v^2}{4g}$ the space a body must descend to acquire the velocity v of the shot, or the space due to the velocity v; consequently the double of this, or $\frac{v^2}{2g} = \frac{v^2}{32\frac{1}{6}}$ is the greatest horizontal range with the velocity v, or at an elevation of 45 degrees, which is nearly half the square of a quarter of the velocity. In other elevations, the horizontal range is as the sine of double the angle of elevation; so that, any other elevation being e, it will be,

As radius $1 : \sin. 2e :: \frac{v^2}{32\frac{1}{6}} : \frac{v^2}{32\frac{1}{6}} \times \sin. 2e$, the range at the elevation e, with the velocity v. But in a resisting medium, like the atmosphere, the actual ranges fall far short of the above theorems, in so much that with the great velocities the actual or real ranges may be less than the tenth part of the potential ranges; so that some balls, which actually range but a mile or two, would in vacuo range twenty or thirty miles. And hence also it happens, that the elevation of the piece, to shoot farthest in the resisting medium, is always below 45°, and gradually the more below it as the velocity is greater, so that the greater velocities with which balls are discharged from cannon with gunpowder, require an elevation of the gun equal to but about 30°, or even less. And the less the size of the balls is too, the less must this angle of elevation be, to shoot the farthest with a given velocity. See Gunnery and Projectiles.

HORN, in physiology, a tough, flexible, semitransparent substance, intended for the defence or covering of animals. The hollow horns of the ox, goat, &c.; the hoof, the horny claw and nail, and the scale of certain insects, as the shell of the tortoise, resemble each other in chemical characters; but they differ very widely from stag's horn, ivory, &c. Horn is distinguished from bone, in being softened very completely by heat, either naked, or through the medium of water, so as to be readily bent to any shape, and to adhere to other pieces of horn in the same state. Horn contains but a small portion of gelatine, and in this it differs from bone, which contains a great deal. Horn consists chiefly of condensed albumen, combined with a small and varying

portion of gelatine, with a small part of phosphate of lime. The fixed alkalies readily and totally dissolve horn into a yellow saponaceous liquor.

Horn and tortoise-shell are applied to mechanical purposes, which require them to be bent and united in various ways; this is performed by the aid of heat, applied either dry, with warmed irons or burning charcoal; or, by softening the horn in boiling water, or in a weak solution of alkali: when thus softened, they will easily adhere. Mr. Aiken gives the following process for making the horn-ring that surrounds a common opera-glass: "A flat piece of horn is cut out, of the requisite shape, the ends to be joined are thinned down by a file, the piece is then put into boiling water till sufficiently supple, and is then rolled round a warm iron cylinder, and held in that position by a vice, so that the ends over-lap each other: another piece of iron, heated and grooved, is then laid upon the seam of the joined ends, and pressed upon the cylinder, and there confined by an iron wire; and the heat of the two, partially melts that portion of the horn, and cements the ends so completely, that no seam or joining can be observed when cold." For the manner of making horn to imitate tortoise-shell, see COMB.

HORN is also a musical instrument of the wind-kind, chiefly used in hunting, to animate the hunters and the dogs, and to call the latter together.

The French horn is bent into a circle, and goes two or three times round, growing gradually bigger and wider towards the end, which in some horns is nine or ten inches over.

HORNS *of insects*, the slender oblong bodies projected from the heads of those animals, and otherwise called antennæ, or feelers. The horns of insects are extremely various; some being forked, others plumose or feathered, cylindrical, tapering, articulated, &c. As to the use of these parts, some have imagined they served to wipe and defend the eyes; others, that they served as feelers, lest the creature should run against any thing that might hurt it; and others there are, who think them the organs of smelling.

HORN *ore*, in mineralogy, is one of the species of silver ore; its most frequent colour is pearl-grey, of all degrees of intensity, which borders sometimes on milk-white, and sometimes approaches to lavender and violet-blue. It passes also, though but rarely, into green. It is found massive, disseminated in thick membranes, in roundish hollow balls; also crystallized: specific gravity 4.8. When heated on charcoal before the blow-pipe, it melts quickly, and leaves a globule of silver; it is even fusible by the flame of a candle; it takes a polish by friction; and its constituent parts, according to Klaproth, are

Silver	67.75
Muriatic acid	21.
Sulphuric acid	0.25
Oxide of iron	6.0
Alumina	1.75
Lime	0.25
	97.00
Loss	3.00
	100.00

It occurs in veins, and generally in their upper parts, and is usually accompanied with brown iron ochre, and with silver glance, but seldom with native silver and red silver ore. It occurs in considerable abundance in the mines of South America, in some parts of France, and in Hungary. It derives its name from its property of cutting like horn; and is, of course, soft, flexible, and ductile, when obtained in thin plates.

HORN *stone*, or HORN *steen*, in mineralogy, a species of the flint genus, divided by Werner into three sub-species: the splintery, the conchoidal, and the wood-stone. The most common colour of the splintery horn-stone is grey; it is found in veins, in the shape of balls, in lime-stone, and forming the basis of porphyry, in several parts of Germany, and also in the Shetland islands. It appears to differ from quartz in containing a greater proportion of alumina; when it contains a very large quantity, it passes into jasper. It sometimes borders on chalcedony and flint. The best mill-stone, called French burr, is cellular-splinter hornstone. Conchoidal hornstone occurs in beds, accompanied with agate, and is distinguished from the splintery by the lightness of its colours, its fracture, and its inferior translucency and hardness.

In the woodstone several colours occur together, and it commonly exhibits coloured delineations, as clouded and striped, and these arrange themselves in the direction of the original woody texture. Its shape is exactly conformable to its former woody shape, so that it occurs in the form of trunk, branches, and roots. It is found in sandy

loam, in Germany and in Ireland. It receives a good polish, and serves the purpose of agate.

Mr. Jameson observes, on this mineral, that, "at first sight it may appear inconsistent, to consider a petrifaction as a particular fossil species; when we reflect, however, that woodstone differs in its external characters from all other fossils, the justness of the Wernerian method will become evident. Many other fossils occur in the shape of petrifactions, but they are almost always identical with some known species, and therefore are to be considered only as varieties of the external shape of the particular fossil to which they belong."

HORN *work*, in fortification, an out-work composed of two demi-bastions, joined by a curtin.

HORN *geld*, a tax paid for feeding of horned beasts in the forest. See FOREST.

HORNBLENDE, in mineralogy, a species of the clay genus, of which there are four sub-species; *viz.* the common, the Labrador, the basaltic, and the hornblende slate. The common hornblende is of a greenish black, or raven-black, which in some varieties approaches to a greyish and even velvet black. It occurs in mass, disseminated and crystallized. Its specific gravity is from 3.6 to 3.8. It is opaque, gives a greyish streak, is moderately hard, and easily frangible; it exhales an argillaceous odour. It melts before the blow-pipe into a greyish-black glass; the constituent parts, according to Kirwan, are,

Silica	37.0
Alumina	22.0
Magnesia	16.0
Lime	2.0
Oxide of iron	23.0
	100.0

The common hornblende forms one of the essential ingredients of several mountain rocks; is sometimes accidentally disseminated in others; and occurs in beds. When in beds, it is frequently accompanied with ores, as magnetic iron-stone, iron pyrites, &c. It is found in all the northern parts of Europe; and when pure is a capital flux for iron ores, to which purpose it is applied in Sweden, where it is obtained in large quantities.

The Labrador hornblende is found in the island of St. Paul, on the coast of Labrador, is usually of a brownish black, and its specific gravity is 3.38. The hornblende slate is of a colour intermediate between greenish and raven black; it is massive, and is generally mixed with mica and felspar. It occurs in beds of primitive rocks, particularly in clay slate; also in gneiss and mica slate, and is found principally in the northern parts of Europe. The basaltic hornblende is of a velvet black, occurs almost always in single imbedded crystals, which are small and middle sized. The surface is smooth and shining, except where it happens to be covered by a thin ochery crust. The specific gravity is rather less than that of the hornblende slate. It melts before the blow-pipe into a brownish-black glass. Bergman has analyzed it, and found it contained.

Silica	58.0
Alumina	27.0
Iron	9.0
Lime	4.0
Magnesia	1.0
	99.0
Loss	1.0
	100.0

It is found in Saxony, Bohemia, Scotland, Italy, &c. It resists decomposition longer than basalt, hence crystals of it are found in clay, formed by the decomposition of basaltic rock. Common hornblende is difficultly frangible, but the basaltic is very easily frangible.

HORNET. See VESPA.

HOROLOGY. Horology is that branch of science which enables us to measure the portions of time. We judge of the lapse of time by the succession of sensible events; and the most convenient and accurate measures of its quantity are derived from motions, either uniform, or else repeated at equal intervals. Of the former kind, the rotation of the earth on its axis is the most exact, and the situation of its surface with regard to the fixed stars, or less simply, with regard to the sun, constitutes the means for determining the parts of time as they follow each other. See ASTRONOMY and DIALLING. Of the latter kind, the rotation of machinery, consisting of wheel-work, moved by a weight or spring, and regulated by a pendulum or balance, affords instruments of which the utility is well known. The term horology is at present more particularly confined to the principles upon which the art of making clocks and watches is established. A considerable portion of this extended subject of research has been given under the articles CLOCK and

CHRONOMETER. In the present, we shall chiefly attend to the means by which the train of wheel-work is made to make a number of successive advances, all so very nearly equal in the measurement of time, that a surprising degree of precision is obtained in ascertaining the intended object.

The machines which, for centuries, have been commonly used to measure time, consist of a movement, or train of wheels, drawn by a weight or spring, and a regulator, the object of which is to keep the motion of the train within the required degree of uniformity. A continual rotatory motion, which constantly tends to accelerate, is thus corrected by means of an alternate motion; while the power which carries round the movement, restores also, to the regulator, the action lost by friction and other causes. The mechanism, by which the two principal parts act on one another, is called the escapement; and this most admirable contrivance may be reckoned the distinguishing characteristic of the modern art of time-piece making.

One of the most ancient escapements is that which is now applied in almost all common pocket watches. It is represented in fig. 1. Plate HOROLOGY, and is best suited to the long vibrations of the balance, which was invented earlier than the pendulum. A B denotes the rim of a contrate wheel, called the crown wheel, having its teeth pointed and sloped on one side only, so that the points advance before any other part of the teeth, during the motion. C and D are two pallets or flaps, proceeding downwards from the verge E F. The pallets are nearly at right angles to each other; and when the balance F G, fixed to the verge, is at rest, the pallets remain inclined to the plane of the wheel, in an angle of about forty-five degrees; but when it is made to vibrate, one of the pallets is brought nearer to the perpendicular position, while the other becomes more nearly parallel. The wheel must be supposed to have one of its teeth resting against a pallet, by virtue of the maintaining power. This tooth will slip off or escape, as the pallet rises towards the horizontal position, at which instant a tooth on the opposite side of the wheel will strike against the other pallet which is down. The returning vibration, by raising this last pallet, will suffer that tooth to escape, and another tooth will apply itself to the first-mentioned pallet. By this alternation, the crown-wheel will advance the quantity of half a tooth each vibration, and the balance or pendulum will be prevented from coming to rest, because the impulse of the teeth against the pallets will be equal to the resistances from friction and the re-action of the air.

The common escapement here described, was well known to Leonardo de Vinci, who describes an instrument acting by an escapement of this kind, similar, as he says, to the verge of the balance in watches, which he does not seem to mention as a new thing: he died about 1513. The isochronism of the pendulum was known to Galileo in 1600, who, before his death, namely, about 1633, proposed to apply it to clocks. The actual application by Huygens was made before 1658, when he published his "Horologium Oscillatorium." He applied it by means of the common escapement already in use with the balance, and still retained in our table-clocks. Sanctorius had made the same application about forty years before that time, as appears by his "Commentarii in Avicennam," (quest. 56), printed in 1625, in which several instruments are described as having been publicly exhibited and explained to his auditors at his lectures in Padua, for thirteen years previous to that time.

This escapement not being adapted to such vibrations as are performed through arcs of a few degrees only, another construction has been made, which has been in constant use in clocks for this century past, with a long pendulum beating seconds. (Fig. 2.), A B represents a vertical wheel, called the swing wheel, having thirty teeth. C D represents a pair of pallets connected together, and moveable, in conjunction with the pendulum, on the centre of axis F. One tooth of the wheel, in the present position, rests on the inclined surface of the inner part of the pallet C, upon which its disposition to slide tends to throw the point of the pallet further from the centre of the wheel, and consequently assists the vibration in that direction. While the pallet C moves outwards, and the wheel advances, the point of the pallet D, of course, approaches towards the centre, in the opening between the two nearest teeth; and when the acting tooth of the wheel slips off, or escapes from the pallet C, another tooth on the opposite side immediately falls on the exterior inclined face of D, and by a similar operation, tends to push that pallet from the centre. The returning vibration is thus assisted by the wheel, while the pallet C moves towards the centre, and re-

HOROLOGY.

Fig. 1.

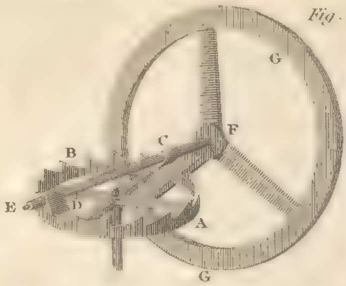


Fig. 2.

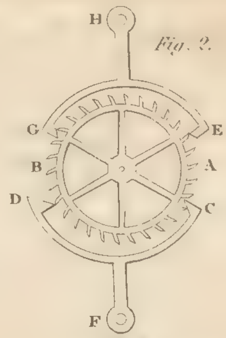


Fig. 3.

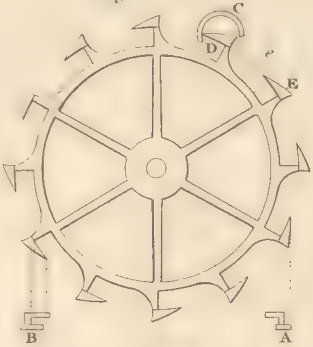


Fig. 4.

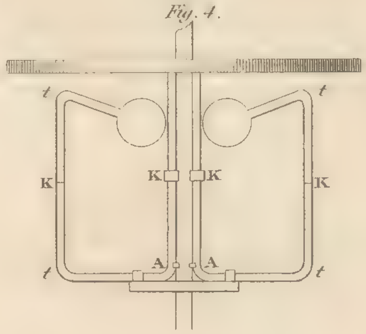


Fig. 5.

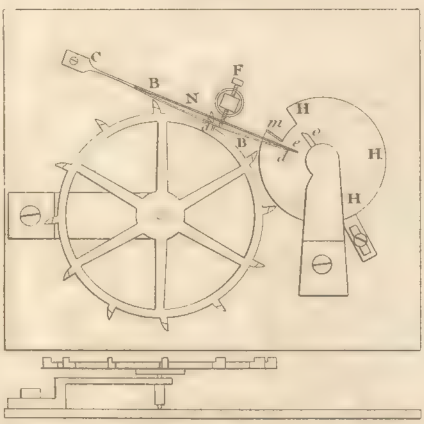


Fig. 7.

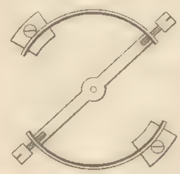


Fig. 6.

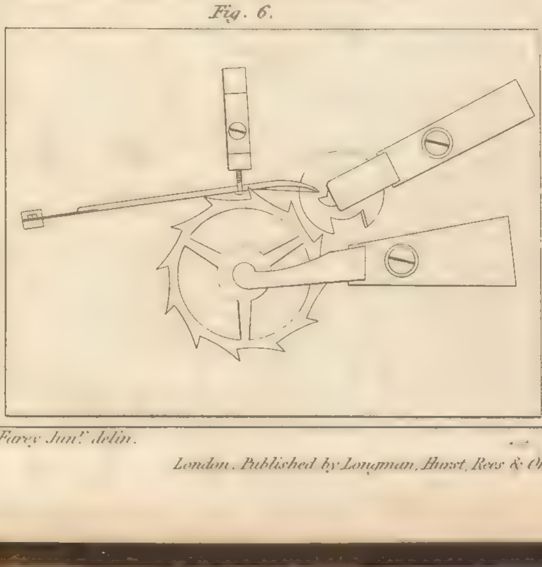
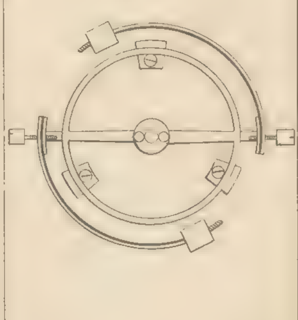


Fig. 8.



J. Farey Jun.r delin.

Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, Sep.r 1808.

ceives the succeeding tooth of the wheel after the escape from the point of D. In this manner the alteration may be conceived to go on, without limit.

The celebrated George Graham improved this escapement very much, by taking off part of the slope furthest from the points of the pallets; instead of which part, he formed a circular or cylindrical face, having its axis in the centre of motion. Pallets of this kind are seen on the opposite side of the wheel at E and G, having H for their centre or axis. A tooth of the wheel is seen resting upon the circular inner surface of the pallet G, which is not therefore affected by the wheel, excepting so far as its motion, arising from any other cause, may be affected by the friction of the tooth. If the vibration of the pendulum be supposed to carry G outwards, the slope surface will be brought to the point of the tooth, which will slide along it, and urge the pallet outwards during this sliding action. When the tooth has fallen from the point of this pallet, an opposite tooth will be received on the circular surface of E, and will not affect the vibration, excepting when the slope surface of E is carried out so as to suffer the tooth to slide along it. In the two former escapements, there is always a certain portion of vibration takes place after the drop which drives the pallets back, and causes the index also to recede through a small arc: this has been distinguished by the name of a recoil. Other considerable objections, besides that of the continued action of the maintaining power, have been made against escapements with a recoil; but it would lead us too far into the minute departments of this subject, to discuss them. The escapement of Graham, and all such as have no recoil, have been called dead beat escapements, because the index for seconds falls directly through its arc, and remains motionless on the line of division till the next vibration. It may be observed, that the maintaining power in Graham's escapement, may be applied during a small portion only of the vibration; and that an increase of the maintaining power tends to enlarge the arc of vibration, but scarcely interferes with its velocity.

The effect of the escapement which has been termed horizontal, because the last wheel in watches of this construction has its plane parallel to the rest of the system, is similar to that of the dead beat escapement of Graham. In fig. 3, the horizontal wheel is seen with twelve teeth, upon each of which is fixed a small wedge supported above the plane of the wheel, as may be seen at the letters A and B. On the verge of the balance there is fixed part of a hollow cylinder of steel, or other hard material, the imaginary axis of which passes through the pivots of the verge. C represents this cylindrical piece, into which the wedge D, may be supposed to have fallen. While the vibration causes the cylindrical piece to revolve in the direction which carries its anterior edge towards the axis of the wheel, the point of the wedge will merely rub the internal surface, and no otherwise affect the vibration of the balance than by retarding its motion. But when the return of the vibration clears the cylinder of the point of the wedge D, the wheel will advance, and the slope surface of the wedge acting against the edge of the cylinder will assist the vibration of the balance. When the edge of the cylinder arrives at the outer point of the wedge D, its posterior edge must arrive at the position denoted by the dotted lines of continuation; immediately after which the wedge or tooth E will arrive at the position *e*, and rest on the outer surface of the cylinder, where it will produce no other effect than that of retardation from friction, as was remarked with regard to the wedge D, until the course of the vibration shall bring the posterior edge of the cylinder clear of the point of the wedge. In this last situation the wedge will act on the edge of the cylinder, and assist the vibration, as in the former case, until that edge shall arrive at the outer or posterior point of the wedge; immediately after which, the leading point will fall on the inner surface of the cylinder in the first position, as was shewn in the wedge D.

Time-pieces, with a pendulum regulator, are certainly the most perfect, when they are kept in a fixed situation; and, for that reason, these are the only sort used in astronomical observatories. But external motion is so contrary to the regularity of their performance, that no sea chronometer has been since attempted to be constructed upon that principle. The balance regulator remained, as affording the only method by which the desired uniformity might be obtained in portable machines; and the great improvement made in that regulator, by the addition of a spiral spring, may be considered as one principal cause of the perfection which has been since attained in them. The first invention of attaching a

spring, to give to the balance, by its elasticity, a power which renders the action of this sort of regulator similar to that of gravity in the pendulum, is undoubtedly due to Dr. Hooke, though it is not so clear whether he ever applied it in the shape of a spiral, as has been so long practised since. F. Berthoud, in his "Histoire de la Mesure du Temps," (vol. i. pp. 134 to 141), gives a body of extracts from several works relative to this subject; and concludes, that Dr. Hooke only applied a straight spring to the balance, and that M. Huygens improved upon that idea, and contrived the spiral spring, which is more favourable to the vibrations of the balance. M. Huygens, indeed, applied in France a balance spring, the account of which has been published in the Philosophical Transactions for 1675, No. 112; but Dr. Hooke, in the Postscript to his Description of Helioscopes, asserts, that the hint was taken from the experiments he had made in 1664, in Gresham College, where he explained above twenty several ways by which springs might be applied to do the same thing.

In relating the progress of time-piece making, we must not omit mentioning the use of precious stones, particularly rubies, to form the holes in which the pivots of the wheels turn, and the pallets upon which the action of the teeth is exercised. These jewels, by the high polish given to them, reduce the quantity of friction; and, not being liable to the wear which takes place in metal rubbing upon metal, the machine with that addition, not only becomes more durable, but acquires a degree of uniformity in the motion of the pieces, which is very favourable to the regularity of its going.

That extraordinary man John Harrison having produced the first portable machines, which, upon repeated trials, met with success, to the extent required for the great reward offered by the British parliament, must be reckoned the father of modern chronometry; and his long and active career has proved extremely useful, by stimulating with so bright an example other artists to similar endeavours. The principles of Mr. Harrison's watches are well known; and, as most parts of his construction have been superseded by more simple contrivances, we shall only mention the principal inventions of which he appears to be the author, and which are still used by the watchmakers of the present day.

The going fusee is one, among those inventions, which has proved the most generally useful in practice. By this simple mechanism, the main spring, while the watch is going, acts on an intermediate short spring, which Harrison calls the secondary spring, and is constantly kept bent to a certain tension by the former; and, when the watch is winding up, and the principal spring ceases to act, the secondary spring being placed in a ratchet wheel, which is hindered from retrograding by a click, continues the motion without alteration. Other contrivances have been proposed, and executed, to make time-pieces go while winding up; but none which, like this, combines the advantage of simplicity, and the property of providing a supplementary power, which is equal to that of the main spring when its action ceases. And it is to be observed, that the utility of the going fusee, which has induced manufacturers to introduce it into all good watches, is peculiarly important in those time-pieces which have not the power of setting themselves in motion, as is the case with the best modern escapements.

Harrison invented also a compensation for the effects of heat and cold, which at the time was perfectly new, and has led to the improvements made afterwards in that essential requisite of time-keepers.

The alterations to which the length of the pendulum is liable by the different degrees of heat and cold, affect the going of clocks with that sort of regulator (see Pendulum); and watches, with a balance, are still more subject to irregularity from that source; because not only the balance expands or contracts, according to the rise or fall of the thermometer, but the regulating spring itself, while it suffers similar changes, becomes weaker or stronger; so that, from these causes, a time-piece must go slower or faster in too great a proportion to be overlooked or neglected. Graham (Philosophical Transactions, 1726), is the first who thought of applying two metals of different expansibility, to correct the errors proceeding from the variation of temperature in a pendulum; but as he seemed to have had in view to effect it immediately, without the aid of mechanism, he was obliged to fix on steel and mercury, these being the metals which offered to him the greatest difference of dilatation and contraction. Harrison, by multiplying the bars, increased the total length of the two metals acting on one another, without exceeding the limits of the pendulum; and thereby produced a sufficient compensation with brass and

steel in the compound, or gridiron pendulum, which has been almost universally adopted ever since. This contrivance could not be easily applied to balances; but Harrison, following still the principle of the different expansibility of metals, applied it in a manner which had not been thought of before, and made it act on the spiral spring, in order to produce the desired compensation in the regulator. This method is described as follows: (Principles of Mr. Harrison's Time-keeper, p. xii., notes.) "The thermometer kirb is composed of two thin plates of brass and steel rivetted together in several places, which, by the greater expansion of brass than steel by heat, and contraction by cold, becomes convex on the brass side in hot weather, and convex on the steel side in cold weather; whence, one end being fixed, the other end obtains a motion corresponding with the changes of heat and cold, and the two pins at the end, between which the balance spring passes, and which it touches alternately as the spring bends and unbends itself, will shorten or lengthen the spring, as the change of heat and cold would otherwise require to be done by the hand in the manner used for regulating a common watch."

This kind of compensation has been since applied in other ways; but the method, in general, is liable to some material objections, on account of its altering the length of the balance spring, and the difficulty, perhaps impossibility, of effecting with it an accurate adjustment. Pierre le Roy, eldest son and successor to Julien le Roy, the companion and friend of H. Sully, had the merit of accomplishing the great desideratum of making the compensation on the balance itself. In the chronometer, which was presented to the King of France the 5th August, 1766, and obtained the prize of the Academy of Sciences of Paris the 31st of the same month, that author executed a compensation in the balance, which he has fully explained in his description of that machine. ("Mémoire sur la meilleure Manière de mesurer le Temps en Mer, qui a remporté le Prix double au Jugement de l' Academie Royale des Sciences. Contenant la Description de la Montre à Longitudes, presentée à sa Majesté le 5 Août, 1766." Par M. le Roy, Horloger du Roi. pp. 41 to 44. This Memoir accompanies the account of Cassini's voyage in 1768, published in 1770.) This compensation is composed (fig. 4.) of two thermometers, *t* K *t* A K, of mercury and spirits of wine, made each in the form of a parallelogram, except in the upper branch, which bears the ball containing the spirits of wine, and is a little bent downwards; the mercury is in the lower part, and the vertical branch of the tube, A K, is open at the upper end. These two thermometers are placed opposite one another, the axis of the balance being in the same plane with the centrical lines of the tubes; and the thermometers and balance are solidly attached together, and form a well poised and steady regulator. At the middle temperature of the atmosphere, the quicksilver stands at K A *t* K; but, when an increase of heat occurs, the alcohol, by its expansion, forces the mercury from the exterior branch, *t* K *t*, towards A K, and a portion of the mass of the regulator contracts by approaching the centre. On the contrary, if the variation consist of an additional degree of cold, the mercury moves towards the exterior branch, and the weight towards the circumference of the balance becomes greater. Thus, if the thermometers are well adjusted, the effects of all the changes of temperature in the balance will be compensated, and the regulator will act with the same uniformity as if its figure were not liable to such alterations.

Peter le Roy mentions his knowledge of Harrison's expansion curb acquired soon after he made his thermometrical balance; and he constructed a balance accordingly on the principle of Harrison's curb; the arms or arcs of which act by flexure, and are adjusted by moveable weights. He proved the effect of such arms by experiment; but gave the preference to his own mercurial compensation. Peter le Roy's second invention is the same as is now used: but though so publicly declared in the face of the French government and academy in 1766, Arnold took an English patent for it in 1782.

We have not yet taken any notice of improvements made in the escapement; because after all the plans proposed for this most essential part of chronometers, the principle of what is called the detached escapement is the only one now used; and, being established upon long experience, seems to merit the preference given to it over all the constructions proposed till now. We shall content ourselves with stating in a general manner the beginning and progress of that escapement.

In all the escapements known till the middle of the last century, the escape wheel was in continual contact with the pallets belonging to the axis of the balance wheel;

and the friction proceeding from this circumstance may be considered as a principal source of irregularity in the going of the watches. Suppose, that a regulator should be made so perfect as to be exactly isochronal, while vibrating in a free situation: that advantage would be diminished or lost as soon as it was placed in connection with a train of wheels; and the errors would be more or less, according to the nature and quantity of friction in the escapement. It would be, therefore, extremely useful to secure to the regulator a perfect liberty of vibration, except during the short intervals of time which may be necessary for the action of the escape wheel, to give it a new impulse. This ingenious idea was also started by P. le Roy, and carried into execution by the same artist, in a model which he presented in 1748 to the Academy of Sciences of Paris, and is described in the collection of machines approved by that society for the same year. Vol. vii. p. 385.

The effect or action of Le Roy's escapement in few words is this: An escape wheel is kept in repose by a lever detent. The balance unlocks the detent, and receives an impulse or stroke on a pallet through a part of every second vibration; and during great part of its course it is free and detached.

About the year 1755, according to Count de Bruhl, the late Mr. Thomas Mudge invented a detached escapement, and applied it to a watch which he made for the King of Spain, Ferdinand VI. This is the same escapement that was used by the late Josiah Emery in his chronometers, some of which have gone very well. It differs from the constructions which we have already explained, both in the detent and in the communication of the impulse, which in this mechanism takes place at every vibration; but the date will not suffer us to consider it as the first invention of the detached escapement.

This justly celebrated artist afterwards made a chronometer, in which the vibrations of balance were kept up by secondary springs attached to two pallets, each of which was wound up by the last wheel of the train during the time employed by the balance in its vibration unconnected with that pallet. Though this invention is highly ingenious and was rewarded by parliament, it is now generally considered as unsafe in the locking of the hooks, or detent parts, which terminate the pallets. Mr. Alexander Cumming executed a similar escapement for clocks long before Mudge actually carried his idea into effect, though it has been contended that Mudge had the mere notion much earlier. But Mr. Cumming, to whom our art, and the other branches of mechanics are highly indebted for his labours, and his Treatise on Clock and Watch Making, made his detents separate from his pallets, and by that means avoided the chief defect of the construction afterwards adopted by Mudge. Our limits will not, however, allow us to pursue these and other improvements and variations, adopted by our own and by foreign artists.

We must confine ourselves to the constructions used at present, by the English watchmakers; and shall begin with that of the late Mr. Arnold, as described in his statement, presented by his son to the board of longitude.

The teeth of the escape wheel (fig. 5.) are of a cycloidal shape, in the face part, which is intended for action, the section of which, with those of the two other sides, form a sort of mixed triangle. B B *d* represents the detent, which is formed of a flexible piece or spring, bending between C and N; and in the part N B *d*, which is stronger than the other, is fixed the locking pallet, *a*, opposite an adjusting screw F. The pallet, projecting below the spring detent, locks upon the interior angle of the tooth; suspending the motion of the escape wheel, and leaving the balance to vibrate free, as pointed out in the preceding escapements. The action of the spring detent (for the joint of the detent is itself a spring) presses the locking pallet against the screw, F, except at the time of unlocking the wheel. A very delicate spring, N *e*, called the discharging, or unlocking spring (and also the tender spring), is attached by one end, N, to the spring detent, C B N B *a*; and, passing under the adjusting screw, F, extends a little beyond the extremity, *d*, of the detent itself. H H H is a circular piece attached to the axis of the balance, and, *o*, the discharging pallet. This pallet, when the balance is in motion from *e* to *d*, presses against the end of the discharging spring, *n e*; and, carrying it together with the locking spring, B B *d*, disengages the locking piece, *a*, out of the internal angle of the tooth, with which it was in contact; and the escape wheel then communicates a new power to the balance, by its impulse on a pallet, *m*, which is fixed, or set, in the aperture of the circular piece. As soon as this is done, the spring detent, or locking spring,

falls back to its position against the adjusting screw, F; and the pallet, by receiving or intercepting the next tooth, stops the motion of the escape wheel. When the balance returns from *d* to *e*, the unlocking pallet acts again on the extremity of the discharging spring, but, this being very delicate, gives way without disturbing the detent or locking spring; and the balance, after suffering a trifling degree of resistance by that contact, continues its free vibrations. At the next vibration, the unlocking takes place; and the action of the escapement proceeds successively, as explained before.

The detached escapement used by Mr. Earnshaw is represented in fig. 6, which is taken from his statement presented to the board of longitude. This escapement is similar to that of Arnold's, already described, except in small variations, which will be easily perceived, on a comparison of the two figures. It is besides asserted, and it appears probable from every circumstance relative to these constructions, that the late Mr. Arnold had made use of this form of escapement long before Mr. Earnshaw, but that he laid it aside, in order to adopt the escapement with cycloidal teeth, which he esteemed far preferable. In the escapement we are now considering, the escape wheel is shaped as appears in the figure; and, on the inspection of this representation, it will be easily observed, that the teeth presenting a right line, and escaping by a sharp point, their action cannot be so smooth, and the wear of the whole must be greater, than in the construction with protuberant cycloidal teeth. The detent is of the same kind as the other, and only differs from it, in being stopped by the inside of the head of the adjusting screw, instead of the extremity of the screw itself, and unlocking outwards, and not towards the centre.

The two constructions, which may be considered as the same, differ from the French detached escapements, such as those of F. Berthoud, which we have already explained, in the detent. In the new detent, the pivots are abolished, and the centre of motion is established in the locking piece itself; which, for that purpose, is made flexible near the extremity by which it is fixed. The elasticity of the detent, or locking piece, supplies also the office of a strait auxiliary spring, placed behind the lever of the detent, or a spiral spring, which has been sometimes applied to the axis of the pivots, to keep the detent in the proper situation.

The pivots of the old detent are so slender, that its performance cannot be supposed subject to any considerable degree of friction; and watches, with that kind of detent, have been known to go very well. Some able artists, upon that account, think, that the new detent is only preferable to the other, because it saves work, and is less expensive; but while the spring detent is allowed to perform as well, if not better, than the detent with pivots, which its universal use in this country seems to prove, that property, combined with the economy in the manufactory, must secure to the mechanism in question, the character of an improvement in the construction of time-keepers.

To whom are we indebted for the invention of the spring detent? The general opinion attributes it to the late Mr. Arnold; and we do not see any reason of sufficient weight to refuse him that merit. Mr. Earnshaw has claimed it in his own favour; but Mr. Arnold's labours have, at least, the advantage of priority; and the strength of this advantage, not having been done away by any proofs, which in our opinion can be esteemed satisfactory, must decide our judgment in the present case, as in the like controversies upon other points, which have been considered in the course of this inquiry. The contrivance of the locking spring, or spring detent, therefore, appears to us to be due to the late Mr. Arnold. With regard to this mechanism, it is also worthy of remark, that the invention is entirely English, not a single passage existing in the writings of the French authors, by which any one of them might claim it with reason, or even plausibility. The first mention of any thing like the locking spring, to be found in foreign publications, is the detent without pivots, given by F. Berthoud in his "Supplément au Traité des Horloges Marines;" but that book was published in 1787, that is five years after Mr. Arnold had taken out his patent, and when many watches upon that construction had been in circulation. We cannot, therefore, allow him the credit of this thought; nor do we find that other French artists have availed themselves of that hint, to carry the spring detent to the great degree of simplicity which it has attained in this country.

A little after the invention of the detached escapement, the isochronism of the vi-

brations of the balance, by means of the spiral spring, was, if not newly discovered, at least perfected and brought into general notice; and that principle added a great value to the detached escapement, while this mechanism secured the utility of the principle, by offering the species of insulated balance which it required. From some theories and experiments long known to the world, it would appear that the vibration of a spring might be always supposed of equal duration; and that advantage Dr. Hooke asserted himself to have attained with his invention in watches, which had been shown to several persons. The principle, however, could not be generally trusted, according to Dr. Hooke himself, who, in the postscript to his description of Helioscopes (p. 29,) declares that he had explained how the vibrations might be so regulated, as to make their durations either all equal, or the greater, slower, or quicker, than the less, and that in any proportion assigned. We must suspect that these ideas were not properly digested, or regret that their communication by the author, in his lectures in Gresham College, was not sufficiently explicit to give precise rules for practice, and fix the attention of watchmakers upon the subject. After those hints, the principle seems to have been very little attended to for many years, and the isochronism was frequently attempted to be effected by means of mechanical contrivances in the escapement. Harrison endeavoured to accomplish that important object by the form of the back of the pallets; and on the return of the voyage to Jamaica, added for the same purpose the cycloidal pin, to regulate the balance spring; but this method of adjustment never appeared satisfactory or certain. P. le Roy, in his "Mémoire sur la meilleure Manière de mesurer le Temps en Mer," rewarded in 1766, first announced distinctly the discovery of a general principle, proper to produce the isochronism, by means of the balance spring, which is expressed as follows: "that in every spring sufficiently long, a certain portion of it will be isochronal, whether long or short; that the length of this portion being found, if it be lessened, the long vibrations will be quicker than the short ones; and that on the contrary, if the length be increased, the small arcs will be performed in less time than the great arcs." This important property of the spring, enabled P. le Roy to bring to a happy issue his labours for the improvement of chronometry; and the art is indebted to him for the practical utility of that discovery, as much as for the invention of the detached escapement.

Berthoud found that the spiral spring, in order to be isochronal, must have an ascending force in arithmetical progression, and that this property may be effected, not only by the length of the spring, but by the number of coils, and the tapering or decreasing thickness from the centre to the extremity, &c. He adds, besides the proportions of the tapering in many springs, which he had actually tried, and gives minute accounts of the experiments made with them in several timekeepers.

The late Mr. Arnold applied to the balance the cylindrical or helical spring, which had been employed long before to a variety of purposes instead of the spiral, which had been constantly used in watches since the time of Dr. Hooke and M. Huygens. This is one of the articles of his patent of 1782, whence it would appear, that provided the spring be made of that form, the vibrations cannot fail to be isochronal; but experience is contrary to that notion, and artists are obliged to attend to a variety of circumstances in the application of the helical, as well as that of the spiral spring. At present, some watchmakers think that the helical spring does not possess any advantage with regard to that property; but as the opinion of other persons is in the affirmative, while all the manufacturers, as far as our knowledge goes, agree in considering the cylindrical form as more easily managed than the other, its application seems entitled to the merit of a practical improvement.

Mr. Earnshaw, in the explanation of his timekeepers, presented to the board of longitude, after noticing the insufficiency of the cylindrical spring, states, that he had, by long perseverance, found how to make springs increasing in thickness to the outer end, in order to effect the isochronism of the vibrations. This method of obtaining isochronal vibrations had been long before explained by Berthoud, with regard to the spiral spring, in that part of his treatise on marine time-pieces which we have already quoted.

This artist states, as a considerable discovery, that the balance spring falls off or tires in its strength, and he gives an allowance for it; but the fact is neither so constant nor so equable as to admit of his general remedy.

Fig. 7, represents the balance of a chronometer, or time-piece, as usually made by our artists. A circular groove is turned in the flat face of a piece of steel, and into this groove a piece of good brass is driven, and a little of the solution of borax is applied to prevent oxydation. This compound piece being then put into a crucible; is made sufficiently hot to melt the brass; which in these circumstances adheres firmly to the steel without requiring any solder. The face of the steel is then cleaned, and by proper application of the mechanical means of turning, boring, and filing, the superfluous steel is taken away, and the balance is left consisting of two or sometimes three radii, and a rim, the external part of which is brass, and the internal part steel, the former metal being about twice the thickness of the latter. Some artists solder the metals together; and others plunge the steel balance into melted brass and suffer them to cool together, but the method we have described appears to be the best. In this state the arcs of the rim are then cut through and diminished in their length as in the figure; and near that extremity of each arc which is farthest from its radius, a piece or weight is put on, which can be slided along the arm so as to be adjusted at that distance, which upon trial shall be found to produce a good performance, under the different changes of temperature. For it scarcely need be observed, that the flexure of these arms by change of temperature, will carry the weights nearer to the centre, in hot than in cold weather; and the more, the greater the distance of the weights from the radius. The small screws near the ends of the radii afford an adjustment for time; as the balance will vibrate more quickly the further these are screwed in; and the contrary will be the case if they be unscrewed or drawn further out.

Fig. 8. shews a balance according to a construction used by Arnold, and specified by him to the commissioners of longitude. The expansion weights are cylindrical, and are adjusted upon the arm by screwing: and there is an inner rim upon which three weights are adjusted by sliding. These serve to regulate the going of the time-piece in different positions.

If an uniform ring, with two or more radii placed at equal regular distances, and in all other respects alike, were to be poised on its axis, as a balance, no part would preponderate; but it would remain at rest in any position; and if we suppose the axis itself to be a spring, such as a piece of stretched wire, and we overlook the difference of tension in the wire, which might arise from the weight of the balance itself, in different positions, it is obvious that all the vibrations of that balance, through equal arcs, would be performed in equal times, whether the balance were made to vibrate parallel to the horizon, or in any other position. But in the balance of a time-piece, the pivots of its axis bear very differently, according to the position of the chronometer; and it requires some management to make the frictions the same, whether the axis be turning on one of its ends, or upon the two cylindrical faces of the pivots. And still more than this, since the balance itself has a permanent figure, compared with the spring, which in every part of the vibration alters its distance from the axis, and in every part of its length has a different degree of rotatary motion, it cannot be expected, nor does it happen, that a balance, which is found to be in poize, along with its spring, when out of the chronometer, will make equal vibration, as to time, in all positions when in its place. And in addition to these difficulties, there is one part of the arc of vibration where the force of the spring, and the inertia of the balance, are not simply in opposition to each other, but are combined with the maintaining power; namely, during the action of escape. The remedy for all these difficulties, which is happily adopted in thermometers for use at sea, is to place the axis in a vertical position; by which means the balance itself is not affected by gravity; but for pocket time-pieces, the ingenuity of the artist is called upon for expedients, of which it would be not easy to exhibit a complete theory. The general principle commonly used, and also adopted by Arnold and Earnshaw, as far as can be gathered from the little they say in their specifications to the commissioners of longitude, is to consider the balance, when out of adjustment for position, as a pendulum weight above and below the centre of suspension, acted upon by gravity,— and at the same time urged to a quiescent point by the force of elasticity. In these circumstances the vibrations will be quickest when the point of stable equilibrium is downwards, and they will be slowest in the opposite position of the machine. This leads to the remedy of diminishing either the weight or the radius, on that side which

is lowest when the rate is most quick. Thus if one of the two adjusting screws in fig. 7, were downwards, in the position of quickest rate, that screw would require to be screwed a very little quantity inwards, and the opposite screw to be screwed a like quantity outwards, in order to remedy this imperfection without much change in the other adjustments. And if a like imperfection were found in the vibrations of the balance, when tried in a vertical position, having the lowest point at rest, in a line at right angles to the line passing through the radii, a similar alteration must be made in the expansion weights, either by a careful flexure of the circular arcs, or by altering the quantities of those weights; or else by means of small screws tapped into the weights themselves, and directed towards the centre, like the weights at the extremities of the radii.

By these, and other correspondent means, the balance may be made to keep time, in all those positions wherein its plane shall be perpendicular to that of the horizon; but even in these trials, very great pains and labour may be required to produce a high degree of accuracy; and in this course of operation, the skilful workman may be under the necessity of preparing a great number of expansion weights, and regulating screws, to be applied in trial, whenever the course of adjustment in one part shall carry him beyond the general conditions of the whole machine. And after all, as the quantity of action, in the spring, must alter the quantity of pendulous effect, in this curious and delicate time-measurer, it may be doubted, whether the adjustments for position in the vertical balance can be effectual any longer than while the arcs of vibration continue permanent. This consideration leads us to the necessity of an adjustment in the maintaining power, in order that the vibrations shall not fall off; at the same time that it affords one of the strongest arguments in favour of a remontoire, notwithstanding the experiment of Arnold, which showed that a sea-chronometer (face up) kept the same rate, when those arcs were greatly varied.

When the balance has been adjusted for position in the vertical situation, it does not follow, as a matter of course, that it will keep the same time with its plane horizontal, or face up and face down. In the former cases, the effect of gravity still appears to be combined with that of elasticity, though under circumstances of adjustment; in the latter, gravity seems to be out of the question. If the rate should demand adjustment with the axis vertical, in order to make it agree with that which obtains when the balance is vertical, it appears necessary, that either the inertia or the elastic force should be altered. The former seems to demand such changes of the screws or weights, as may alter the effective radius of the balance; the latter requires a change of the spring itself. The artists with whom the writer of this article has conferred, did not seem to have clear notions of any direct method for effecting the purpose here pointed out. It appeared, that they have recourse to several expedients; but that, in general, the rate, face up, of a time-piece, which has been well adjusted in other respects, does not require much additional adjustment.

From all these considerations, with others into which brevity forbids us to enter, together with those which relate to the choice and preparation of materials, and the delicacy and truth of workmanship, the reader will be able to form some judgment of the intelligence and skill with which, chiefly under the sanction of the British government, this important manufacture has been pursued, and likewise of the ample field for improvement, which remains for the exertions of future artists. See PENDULUM, CLOCK, TRAIN, and WATCH-WORK.

HOROPTER, in optics, a right line drawn through the point where the two optic axis meet parallel to that which joins the centres of the two eyes or the two pupils.

HOROSCOPE, in astrology, is the degree of the ascendant, or the star that rises above the horizon at a certain moment, which is observed in order to predict some future event, as the success of a design, the fortune of a person who was at that instant born, &c. The same name is also given to a scheme or figure containing the twelve houses, in which are marked the situation of the heavens and stars, in order to form predictions. See HOUSE.

HOROSCOPE *lunar*, the point from whence the moon proceeds when the sun is in the ascending point of the east.

HORS *de son fee*, an exception to avoid an action brought for rent issuing out of certain lands, by him that pretends to be the lord, or for some customs and services; for if the defendant can prove the land to be without the compass of his fee, the action fails.

HORSE. Se Equus.

Horse *dealers*. Every person exercising the trade or business of an horse-dealer, must take out a licence from the Stamp Office, for which he shall pay annually, if within London, Westminster, the bills of mortality, the parish of St. Pancras, or the borough of Southwark, twenty pounds; elsewhere, ten pounds.

Horse-dealers who shall, after January 1, 1796, carry on the said business without having obtained a licence under the act of 36 George III. c. 17, shall be liable to be assessed the duties on riding-horses, and shall deliver lists thereof as other persons.

Horses. It shall be lawful for any person, native or foreigner, at any time to ship, lade, and transport, by way of merchandize, horses into any parts beyond the seas, in amity with his majesty, paying for each horse, mare, or gelding, 5*s*. and no more.

No person convicted for feloniously stealing a horse, gelding, or mare, shall have the privilege of clergy. 1 Ed. VI. c. 12. And not only all accessaries before such felony done, but also all accessaries after such felony, shall be deprived and put from all benefit of their clergy, as the principal, by statute heretofore made, is or ought to be.

If an horse be stolen out of the stable, or other curtilage of a dwelling-house, in the night time, it falls under the denomination of burglary; if in the day-time, it falls under the denomination of larceny from the house: and in either case there is a reward of 40*l*. for convicting an offender, and the prosecutor is entitled to a certificate, which will exempt him from all parish and ward offices, in the parish and ward where the burglary, or larceny, is committed, and which may be once assigned over, and will give the same exemption to the assignee as to the original proprietor.

Great abuses having arisen, and many horses having been stolen, from the facility and safety of disposing of them to those who kept slaughter-houses for horses, some regulations and restrictions seemed absolutely necessary. It was no uncommon thing for horses of great value to be sold for the purpose of making food for dogs; the thief rather choosing to receive twenty shillings for a stolen horse, without fear or danger of detection, than venture to dispose of him publicly, though he might possibly have found a purchaser who would have given as many pounds for him. These considerations induced the legislature to pass the act of 26 Geo. III. c. 71, for regulating these slaughter-houses.

Killing or maiming horses. Where any person shall, in the night-time, maliciously, unlawfully, and willingly, kill or destroy any horses, sheep, or other cattle, of any person, every such offence shall be adjudged felony, and the offender shall suffer as in the case of felony. 22 and 23 Car. II. c. 7.

Offenders may be transported for seven years, either at the assizes, or at the sessions, by three justices of the peace; one to be of the quorum.

By the 9 Geo. I. c. 22. commonly called the black act, it is enacted, that if any person shall unlawfully and maliciously kill, maim, or wound, any cattle, every person so offending, being thereof lawfully convicted, in any county of England, shall be adjudged guilty of felony, and shall suffer death, as in cases of felony, without benefit of clergy. But not to work corruption of blood, loss of dower, nor forfeiture of lands or goods.

Prosecution upon this statute shall, or may, be commenced within three years from the time of the offence committed, but not after.

If a horse, or other goods, be delivered to an innkeeper, or his servants, he is bound to keep them safely, and restore them when his guest leaves the house.

If a horse be delivered to an agisting farmer, for the purpose of depasturing in his meadows, he is answerable for the loss of the horse, if it be occasioned by the ordinary neglect of himself or his servants. If a man ride to an inn, where his horse has eat, the host may detain the horse till he be satisfied for the eating, and without making any demand. But a horse committed to an inn-keeper, can only be detained for his own meat, and not for that of his guest, or any other horse; for the chattels in such case, are only in the custody of the law for the debt which arises from the thing itself, and not for any other debt due from the same party. By the custom of London and Exeter, if a man commit a horse to an inn-keeper, if he eat out his price, the inn-keeper may take him as his own, upon the reasonable appraisement of four of his neighbours; which was it seems a custom, arising from the abundance of traffic with strangers, that could not be known so as to be charged with an action. But it hath been holden, though an inn-keeper in London may, after long keeping, have the horse appraised and sell him, yet, when he has in such case had

him appraised, he cannot justify the taking him to himself, at the price he was appraised at. And this cannot be done at any other place by the common law, unless there is some special custom.

HORSE, in naval affairs, a rope reaching from the middle of a yard to its extremities, and depending about two or three feet under the yard, for the sailors to tread on while they are loosing, reefing or furling the sails; rigging out the studding sail-booms, &c. The same word is used for a thick rope extending in a perpendicular direction near the fore or aft-side of a mast, for the purpose of hoisting some yard or extending a sail upon it: when before the mast, it is used for the square sail, whose yard is attached to the horse by means of a traveller which slides up and down. When it is abaft the mast, it is intended for the try sail of a snow, but it is seldom used in this position except in sloops of war that occasionally assume the appearance of snows to deceive the enemy.

HORSE *leach*. See HIRUDO.

HORTUS *siccus*, a *dry garden*, an appellation given to a collection of specimens of plants, carefully dried and preserved. The value of such a collection is very evident, since a thousand minutiæ may be preserved in the well-dried specimens of plants, which the most accurate engraver would have omitted. We shall, therefore, give some methods of drying and preserving an hortus siccus. Specimens ought to be collected when dry, and carried home in a tin box. Plants may be dried by pressing in a box of sand, or with a hot smoothing iron. Each of these has its advantages. If pressure be employed, a botanical press may be procured. The press is made of two smooth boards of hard wood, eighteen inches long, twelve broad, and two thick. Screws must be fixed to each corner with nuts. If a press cannot easily be had, books may be employed. Next some quires of unsized blotting paper must be provided. The specimens, when taken out of the tin box, must be carefully spread on a piece of pasteboard, covered with a single sheet of the paper quite dry; then place three or four sheets of the same paper above the plant, to imbibe the moisture as it is pressed out; it is then to be put into the press. As many plants as the press will hold may be piled up in this manner. At first they ought to be pressed gently. After being pressed for twenty-four hours or so, the plants ought to be examined, that any leaves or petals which have been folded may be spread out, and dry sheets of paper laid over them. They may now be replaced in the press, and a greater degree of pressure applied. The press ought to stand near a fire, or in the sunshine. After remaining two days in this situation, they should be again examined, and dry sheets of paper be laid over them. The pressure then ought to be considerably increased. After remaining three days longer in the press, the plants may be taken out, and such as are sufficiently dry may be put in a dry sheet of writing-paper. Those plants which are succulent may require more pressure, and the blossom paper again renewed. Plants which dry very quickly, ought to be pressed with considerable force when first put into the press; and if delicate, the blossom-paper should be changed every day. When the stem is woody, it may be thinned with a knife, and if the flower be thick or globular as the thistle, one side of it may be cut away; as all that is necessary, in a specimen, is to preserve the character of the class, order, genus, and species. Plants may be dried in a box of sand in a more expeditious manner, and this method preserves the colour of some plants better. The specimens, after being pressed for ten or twelve hours, must be laid within a sheet of blossom-paper. The box must contain an inch deep of fine dry sand, on which the sheet is to be placed, and then covered with sand an inch thick; another sheet may then be deposited in the same manner, and so on, till the box be full. The box must be placed near a fire for two or three days. Then the sand must be carefully removed, and the plants examined. If not sufficiently dried, they may again be replaced in the same manner for a day or two. In drying plants with a hot smoothing iron, they must be placed within several sheets of blotting paper, and ironed till they become sufficiently dry. This method answers best for drying succulent and mucilaginous plants. When properly dried, the specimens should be placed in sheets of writing-paper, and may be slightly fastened by making the top and bottom of the stalk pass through a slip of the paper, cut nearly for the purpose. Then the name of the genus and species should be written down, the place where it was found, nature of the soil, and the season of the year. These specimens may be collected into genera, orders, and classes, and titled and preserved in a port-folio or cabinet. The method of preserving many of

the cryptogamous plants is more difficult, on account of the greater quantity of moisture which they contain, and the greater delicacy of their texture.

HOT *house.* This convenience is productive of many articles at the tables of the rich and luxurious, and may be said to constitute the chief pride of many gardeners, and indeed of many persons in the highest circles of society. Illiberal persons are, however, prone to decry those productions which do not ordinarily enter within their own use and consumption, and it is not unusual to hear many execrations uttered against hot-houses, temples, &c. and other edifices which ornament the gardens and pleasure grounds of the affluent, under the idea that the money so expended is thrown away. But when we consider how many families are maintained by the labour required, either in manufacturing, or in appropriating the several materials, we certainly may consider hot-houses in particular as claiming an exemption from such indiscriminate censure.

In truth, hot-houses are highly useful; they not only serve to give a stimulus to common gardeners, of whom many affect to vie in early productions, but they serve as the receptacles for those exotics which could not be reared, nor even preserved, were it not for the similarity thus artificially produced with their native climates. We have various instances of the naturalization of foreign shrubs, &c. which in time become nearly as hardy as our indigenous plants of the tender class; but which could never have been propagated, if exposed to the severity of our winter months.

The scite of a hot-house is extremely important, as on this much will depend. A south-south-west aspect is to be preferred, as greatly inducive to economy during the summer time, which, in some seasons are warm enough to obviate the necessity for many expences that in an unsettled year become indispensable; this, in places where fuel is scarce, and consequently dear, is a matter of serious consideration.

The best plan for a hot-house we consider to be a parallelogram, of whatever length may be thought proper; the front wall to be about a foot high, so as to rise above the level of the adjacent surface in such manner as may exclude heavy rain, &c. and to bring the plants to such a level as may give them a full exposure to the sun. On the front wall a perpendicular glass frame, of about two feet and a half, should be raised, so that its upper ledge should stand at full three feet and a half above the ground. This is necessary for the purpose of allowing the sliding frames to be drawn out on occasion, and to give height within for the gardener's operations. The breadth of the interior ought not to exceed fourteen feet, and the back wall should be high enough to give the top, or sliding frames, an angle of thirty-five degrees from the horizon. The tan-binns should be excavated in a diagonal manner; shallow in front, but at their back to the depth of six feet, and divided off into compartments, so that each portion, say six feet square, might be supplied as occasion should demand, with fresh tan, without causing the adjoining parts to be disturbed, or, as is too often the case, to fall in.

The surface of the tan-binns should partially correspond with the angle made by the upper glass frames, or at least it should stand at an angle of full twenty degrees from the horizon; so that the plants should not lay on a flat bed, but rise like a flight of steps towards the back of the tan-binns. By this means, when the excavation, which in this mode need scarcely be a foot in depth, is filled with tan, it will give various degrees of heat, according to the depth, in each part respectively, as it may be more or less removed from the front of the hot-house. We, however, rather recommend that only half should consist of hot-beds, and that the front part be built up with benches of masonry, perfectly air tight, through which flues should be made, whereby such pots as might stand on them, would receive a degree of warmth sufficient to preserve many of the more hardy exotics. We likewise are disposed to consider sliding frames to be far inferior, both in regard to their safety, and as relating to the closeness of shutting, to such as are made to rise on hinges at their upper ends, and which having projecting battens to throw off the wet into the centre of their supporting rafters (which should be grooved to receive the wet, and to conduct it downwards) effectually exclude exterior moisture, and, by being listed within, debar the access of frost. We have, in Plate VII. Miscel. given some idea of this arrangement, wherein fig. 1 shows the internal section of the hot-house, with the binns for receiving the tan; also the angles of the surfaces, both of the tan-binns and of the glass frames; the latter being divided into two or more parts, may be opened at pleasure, by means of

the racks, to any height. The benches in front are all flued, and rise *en escalier*, *i. e.* by regular steps, for the purpose of displaying all the plants standing on them, and to give them a proper portion of the sun's influence, without which no plant will thrive, or be either so well flavoured, or so highly coloured. In fact, warmth without light will produce no good effect on the vegetable world.

Fig. 2, displays the manner in which the flues are made to meander through the several benches, between which the intervals should be filled up, to within two feet of their tops; thereby to allow the means of shifting, watering, or the whole may be built up as in fig. 3, provided their joint breadths do not exceed three, or three and a half feet; if more they would preclude the possibility of giving the due attention to each individually. The square black spaces, under each bench, shows the passage of the flues, the sides being half a brick in thickness, and the tops covered only with a strong tile, well cemented down, and plastered over. By this means any part of the flues can be easily cleaned or repaired. Our readers will of course understand that where any part of the hot-house is thus benched, it need not be excavated, that mode being only requisite for the lodgment of the tan in the parts intended for keeping up the heat by immersion of the pots in the hot beds.

The average heat of the interior should be from about 75 to 80 degrees; but at particular critical times, when pines, &c. require much forcing, it may be carried up to full 85, or even to 90 degrees, so as to correspond with the temperature of their natural climate. It is remarkable, that in those places where pines grow wild, they possess the highest flavour, far exceeding that of the domesticated fruit, and that they ordinarily undergo a change of about 12 or 15 degrees between the average heats in the shady parts, where they grow, at mid-day, and at mid-night. Yet our gardeners keep them full as warm during the night, as during the day. Perhaps some assiduous and curious speculator in this branch of horticulture, may deem the above hint worthy of notice.

The entrance into a hot-house should always be by means of a small anti-chamber, shutting very close; for when a door opens abruptly, so as to admit the external air, those plants which are contiguous thereto will receive a shock from the cold air, thus inevitably allowed to reach them, and will be far less luxuriant than others of the same kind, which, by a more fortunate locality, escape the baneful influence. We would recommend the sketch given in fig. 4, to the attention of our readers; in it A is the anti-chamber to the hot-house B, and C is the fire-place whence the chimney forms the several flues that pass under the benches, and through the back wall D, C ending in the chimney, E.

It will be found most convenient to have the door in the centre of one end of the hot-house, and as that part will necessarily be raised by the slope of the surface of the beds and benches, four or five steps may be made, either in the anti-chamber, or in the hot-house. It will also be found useful to make in the back wall various small apertures, one for each bin, that the old tan, which has lost its heat, may be removed from below by means of scoops and hoes; the surface of the bin being, in the meanwhile, covered with bass-mats, straw, &c., to exclude the external air. When the old tan has all been removed, the aperture should be closed, and the fresh tan be filled into the bin by two men, with a long narrow basket, which might be advantageously rolled up the path-way or alley, between the bins and the benches, on a small truck-frame.

In small hot-houses, such as we sometimes see in the gardens attached to little country boxes, the heat might be circulated from a kitchen fire, provided the benches were raised sufficiently high to receive that benefit without affecting the draught. This would, in many instances, be found convenient and economical. In such the air might be admitted, merely by having one or two panes of glass set in metal frames; to be opened on hinges, as we often see, in places where sash windows would not answer, or where only a slight change of air is needful.

We shall conclude this article with remarking that hot-houses require considerable attention, and are extremely expensive, both in their construction and in their support. A thermometer should always be suspended in some shady part; and, in warm weather especially, it will be found extremely convenient to have tin ventilators set in the sides, near the tops, as shown in the figure, their action might at any time be stopped, by putting on a tin cap or cover, or by a sliding board; the latter would prove most convenient.

During the day time, in the summer season, the fires may frequently be allowed to go out; but so soon as the evening chill is felt, the glasses ought to be closed, and the flues to be heated. As, however, some plants require more air than others, we offer to the consideration of our horticultural readers, whether a perpendicular glazed frame, dividing the hot-house longitudinally into two distinct parts, the front one to be kept partially opened, and the back one completely closed, would not be an improvement in the construction of this species of buildings. This might be so contrived as more effectually to guard against the sudden access of cold air, and serve as an auxiliary to the precaution already suggested, of having the entrance guarded by means of an anti-chamber. The manner of attending to the plants in hot-houses will be seen under the head of GARDENING, where we have endeavoured to furnish a complete, but concise essay and calendar, and in which every matter of utility, of ornament, and of luxury, has been allowed its due notice.

HOTTONIA, in botany, *water-violet*, so named in honour of Peter Hotton, professor of botany at Leyden, a genus of the Pentandria Monogynia class and order. Natural order of Palmæ. Lysimachiæ, Jussieu. Essential character: corolla salver shaped; stamina placed on the tube of the corolla; capsule one-celled. There are four species.

HOVENIA, in botany, so named in honour of M. Hoven, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: petals five, convoluted; stigma trifid; capsule three-celled, three-valved. There is but one species, *viz.* H. dulcis, a native of Japan, near Nagasaki.

HOVERING, in law, ships of fifty tons, laden with customable or prohibited goods, hovering on the coasts of this kingdom, within the limits of any port (and not proceeding from foreign parts) may be entered by officers of the customs, who are to take an account of the lading, and to demand and take a security from the master, by his bond to his Majesty, in such sum of money as shall be treble the value of such foreign goods then on board; that such ship shall proceed, as soon as wind and weather, and the condition of the ship will permit, on her voyage to foreign parts, and shall land the goods in some foreign port; the master refusing to enter into such bond or demand, or who having given bond, shall not proceed on such voyage (unless otherwise suffered to make a longer stay by the collector, or other principal officer of such port where the vessel shall be, not exceeding twenty days); in either of the said cases, all the foreign goods on board, may be taken out by the customhouse officers, by direction of the collector, and properly secured; and if they are customable, the duties shall be paid, and if prohibited, they shall be forfeited. The officers of the custom may prosecute the same, as also the ship, if liable to condemnation, 3 Geo. III. c. 21. Commanders of men of war, and customhouse officers, may compel ships of fifty tons, or under, hovering within two leagues of shore, to come into port. 6 Geo. I. c. 21. If any ship or vessel shall be found at anchor, or hovering within eight leagues of the coast (except between the North Foreland and Beachy Head) unless by distress of weather, having on board foreign spirits, in any vessel or cask which shall not contain sixty gallons at least, or any wine in casks (provided such vessel have wine on board) shall not exceed sixty tons burthen, or six pounds weight of tea, or twenty pounds weight of coffee, or any goods whatever liable to forfeiture upon importation, that such goods with the ship and furniture, shall be forfeited; spirits for the use of seamen, not exceeding two gallons per man, excepted. 42 Geo. III. c. 82.

HOUND, a hunting dog, of which there are several sorts, as the grey-hound, gaze-hound, &c. See CANIS.

HOUNDS, in naval language, a name given to those parts of a mast-head which gradually project on the right and left side beyond the cylindrical or conical surface, which it preserves from the partners upwards.

HOUR, *hora*, in chronology, an aliquot part of a natural day, usually a twenty-fourth, sometimes a twelfth. But the word hour has not always been of the same signification; for in ancient times an hour did indefinitely express a short space of time. It is thought too that anciently the four seasons of the year, wherein the sun finishes its annual course, had the name of hours, because Horus instituted a certain year, consisting of three months, and for this reason the ancients called spring, summer, autumn, and winter, hours, and the year itself horus: of which some footsteps appear in this, that the Greeks called their annals *Hori*; and the writers of them *ho-*

rographi. However it be, the division of the day into hours is very ancient, though the most ancient hour is that of the twelfth part of the day.

An hour, with us, is a measure or quantity of time, equal to a twenty-fourth part of the natural day, or nychthemeron; or it is the duration of the twenty-fourth part of the earth's diurnal rotation. Fifteen degrees of the equator answer to an hour; though not precisely, yet near enough for common use.

The hour is divided into sixty minutes; the minute into sixty seconds; the second into sixty thirds, &c.

There are divers kinds of hours, used by chronologers, astronomers, dialists, &c. Sometimes hours are divided into equal and unequal. Equal hours are the twenty-fourth part of a day and night precisely, that is, the time wherein fifteen degrees of the equator mount above the horizon. These are also called equinoctial hours, because they are measured on the equinoctial; and astronomical, because used by astronomers. They are also differently denominated, according to the manner of accounting them in different countries. Astronomical hours are equal hours, reckoned from noon, or mid-day, in a continued series of twenty-four. Babylonish hours are equal hours reckoned in the same manner from sun-rise. The Italian hours, are also equal hours reckoned in the same manner too, from sun-setting. European hours are also equal hours, reckoned from midnight; twelve from thence to noon, and twelve more from noon to midnight. Jewish, or planetary, or ancient hours, are the twelfth part of the artificial day and night, each being divided into twelve equal parts. Hence, as it is only in the time of the equinoxes that the artifical day is equal to the night, it is then only that the hours of the day are equal to those of the night: At other times they will be always either increasing or decreasing. And they will be the more or less unequal according to the obliquity of the sphere.

HOUR *glass*, a popular kind of chronometer, which serves to measure the flux of time by the running of sand from one vessel into another. Glasses of this kind for half and quarter hours, and for less divisions of time are much used at sea.

HOUSE, in astrology, denotes the twelfth part of the heavens. The division of the heavens into houses, is founded upon the pretended influence of the stars, when meeting in them, on all sublunary bodies. These influences are supposed to be good or bad, and to each of these houses particular virtues are assigned, on which astrologers prepare and form a judgment of their horoscopes. The horizon and meridian are two circles of the celestial houses, which divide the heavens into four equal parts, each containing three houses; six of which are above the horizon, and six below it: and six of these are called eastern, and six western houses. A scheme or figure of the heavens is composed of twelve triangles, also called houses, in which is marked the stars, signs and planets so included in each of these circles. Every planet has likewise two particular houses, in which it is pretended, that they exert their influence in the strongest manner; but the sun and moon have each of them only one, the house of the former being Leo, and that of the latter Cancer. The houses in astrology have also names given them according to their qualities; the first is the house of life; this is the ascendant, which extends five degree above the horizon, and the rest below it: the second is the house of riches: the third the house of brothers: the fourth, in the lowest part of the heavens, is the house of relations, and the angle of the earth: the fifth, the house of children: the sixth, the house of health: the seventh, the house of marriage, and the angle of the west: the eighth, the house of death: the ninth, the house of piety: the tenth the house of offices: the eleventh, the house of friends: and the twelfth, the house of enemies.

We have given this and other brief accounts of the most absurd of all pretended sciences, in order to show the folly of those who were, in former times, weak enough to give any degree of credit to it.

HOUSED, in sea language, the situation of the guns, upon the middle and lower gun-decks, when they are run in, and the breach being let down, the muzzle gets against the side above port. They are there secured.

HOUSTONIA in botany, so named from William Houston, M.D. a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one petalled, funnel form; capsule superior, two-celled, two-seeded. There are two species, *viz.* H. cœrulea, blue-flowered Houstonia; and H. purpurea, purple-flowered Houstonia, natives of Virginia and Maryland.

HOUTTUYNIA in botany, so called in honour of Mart. Houttuyn, M.D. a genus of the Monoecia Monandria class and order. Natural order of Piperitæ. Aroideæ, Jussieu. Essential character: calyx four-leaved; corolla none; stamens mixed with the pistils. There is only one species, *viz.* H. cordata, it was discovered in Japan, between Miaco and Jeddo.

HOY, in naval architecture, a small vessel fitted only with one mast.

HUDSON'S *bay company*. See COMPANY.

HUDSONIA, in botany, from William Hudson, a genus of the Dodecandria Monogynia class and order. Natural order of Bicornes. Ericæ, Jussieu. Essential character: calyx five-leaved, tubular; corolla none; stamens fifteen; capsule one celled, three valved, three seeded. There is only one species, *viz.* H. ericoides a native of Virginia.

HUE and CRY, is the ancient common law process after felons, and such as have dangerously wounded any person, or assaulted any one with intent to rob him. And it has received great countenance and authority by several acts of parliament. In any of these cases, the party grieved, or any other, may resort to the constable of the vill; and, 1st, give him such reasonable assurance of the fact as the nature of the case will bear; 2. If he know the name of him that did it, he must tell the constable; 3. If he know it not, but can describe him, he must describe him, his person or his habit, or his house, or such circumstances as he knows, which may conduce to the discovery; 4. If the thing be done in the night, so that he knows none of these circumstances, he must mention the number of persons, or the way they took; 5. If none of all these can be discovered, as where a robbery, or burglary, or other felony is committed in the night, yet they are to acquaint the constable with the fact, and desire him to search his town for suspected persons, and to make hue and cry after such as may probably be suspected, as being persons vagrant in the same night; for many circumstances may happen to be useful for discovering a malefactor, which cannot at first be found out. For the levying of hue and cry, although it is a good course to have a justice's warrant, where time will permit, in order to prevent causeless hue and cry; yet it is not necessary, nor always convenient; for the felon may escape before the warrant be obtained. And upon hue and cry levied against any person, or where any hue and cry comes to a constable, whether the person be certain or uncertain, the constable may search suspected places within his vill, for the apprehending of the felon. And if the person, against whom the hue and cry is raised, be not found in the constablewick, then the constable, and also every officer to whom the hue and cry shall afterwards come, ought to give notice to every town round about him, and not to one next town only; and so from one constable to another until the offender be found, or till they come to the sea-side: and this was the law before the conquest. Hue and cry also is good, and must be pursued, though no person certain can be named or described.

HUER, or HVER, the Icelandic name for streams of heated water, which are forced with great violence through apertures in the earth by internal causes to a great height, in that wretched Island. Numerous as are the phenomena of nature, there is none more capable of exciting astonishment and admiration than the huer. These grand fountains far exceed the most celebrated attempts to rival them, by many, very many fathoms, exclusive of possessing the property of increasing their beautiful effect by the discharge of steam in vast volumes, almost resembling fleecy clouds. The heat of the water of the different fountains varies considerably, the fluid flowing gently from some, and spouting upwards from others in an actual state of boiling. Those which have the properties of common springs, except in their heat, are called laug, or a bath; the heat, though unequal, was never known to be less than 188 of Fahrenheit's thermometer, and Dr. Von Troil found the water at Laugarnas 188, 191, and 193. At Geyser, Reykum, and Laugarvatn, 212.

It is not unusual to find the springs closed in some places, with others opened near them; and there are traces of huers without a drop of water in their vicinity. Olafsen asserts, that a huer burst forth at Reikakio, in 1753, forty-two feet in breadth, eighteen in depth, and at three hundred, in distance from a spring, which had been overwhelmed by a fall of the adjoining soil. The water thus impeded in its progress occasioned convulsive motions in the earth, and loud explosions were heard by the inhabitants before the imprisoned stream obtained a vent.

The apertures, through which the water

passes, are lined with an incrustation, which is most pure in those that emit it perpendicularly. This substance is said to resemble chased work, is of a very fine grain, and will not effervesce with acids; unfortunately the circumstances that excite curiosity to examine these springs, prevent its gratification, as it is impossible to explore their depths, or dig round them without danger; an opportunity occurred, however, at Laugarnas, where Dr. Von Troil had the satisfaction of observing the course of a spring through a bright grey clay, "the surface of which was covered with a white rind; but was on the side nearest the clay quite smooth, and crisped on the upper side. The vein flowed a good way under this crust, through a canal formed of a similar matter, and the whole canal was filled with crystals, which had a very pleasing effect." He was interrupted in his attempts to trace the further progress of the water by its retirement to subterraneous passages, where, compressed by exhalations, and acquiring greater heat, it has forced a new course, and gushes out at an opening some distance from the first mentioned.

The water has a sulphurous taste, in some instances, when hot, but is exactly similar to common boiled water when cold. It is used by the inhabitants for dying, and might be applied to many purposes with great advantage, as victuals may be dressed by its heat, merely by placing the meat in a covered vessel immersed in common water, and that in the boiling fluid; they have indeed evaporated sea water over it, and made excellent fine salt; and the cows which drink from the stream after it has cooled, are said to give great quantities of good milk. Olafsen says, that syrup of violets will not change its colour, and that alkali has no effect when thrown into it. There cannot be a doubt that the heat of these springs and fountains is derived from the volcanos of the island, but for obvious reasons they are seldom found very near them; they are common throughout the country, in the vallies between mountains, and even the summits of the ice mountains have their huers, particularly Torfa Jockul, which abounds with hot springs, and two send their water to a great height; besides those, there is a luke warm spring near Haadegis Hunk, on Gutland's Jockul, at the base of the mountain, with numerous marks of closed huers. The influence which urges this heated water upwards is so considerable as to force it in that state through the cold medium of the sea, the steam accompanying it, floating from the place, and pointing out the situation of the spring. Dr. Von Troil enumerates many separate huers and fountains, which he visited in different parts of the island; amongst those the valley of Reykholts contains the greatest number. This vale is two miles and a half in breadth, and the steam arising from it is conspicuous for several miles, producing an appearance exactly similar to the smoke ascending from a volcano. The huers at Oelves are supposed to be the largest in Iceland; and the most remarkable are Geyser and Badstofn; there is one at this place which emits vapour only, but so very hot that water may be boiled by holding it above the steam a few minutes.

Geyser is situated about two days journey from Mount Hecla, near a farm called Haukadal. Here, says Dr. Von Troil, a poet would have an opportunity of painting a picture of whatever nature has of beautiful and terrible united, by delineating one of its most uncommon phenomena; it would be a subject worthy the pen of a Thomson, to transport the reader, by poetical imagery, to the spot which is here presented to the eye. A spacious plain, bounded on one side by very distant mountains, covered with ice, and their summits enveloped in clouds, which frequently changing their position, descend to their bases, leaving the pointed crags as if resting upon them, are the least interesting part of the wild and chilling wonders surrounding Geyser. Hecla frowning with volcanic majesty, and exhibiting three vast pyramids encrusted with ice, towering far above the clouds, sends forth enormous volumes of smoke, which floating away in the direction of the wind, and uniting with them, forms another portion of this horrid circle, which is completed by a ridge of high rocks, wetted by the steams exhaling from springs gushing in a state of ebullition at their feet, and a marsh half a mile in circumference, whence the vapours of fifty others ascend to an amazing height. In the centre is Geyser, the approach to which is perceived at a considerable distance by the rushing noise it occasions, resembling the fall of a cataract over precipices. The aperture whence the water proceeds, is nineteen feet in diameter; but the bason or excavation made by the descent of the fluid, is fifty-nine feet in breadth,

each is covered by a rough stalactic crust, and the latter is nine feet higher than the aperture.

The water has not been known to ascend regularly in a continued stream, but in sudden impulses after rather long intervals of quiet. The inhabitants of the neighbourhood assert, that the ascent is higher in cold bad weather than at other times, and they, and other observers affirm, that it is elevated sixty fathoms, though without any means of deciding beyond mere conjecture, indeed, the method adopted by Dr. Von Troil and his friends, to ascertain the height to which the water ascended on the 21st of September, 1772, was equally fallible; they supposed the greatest elevation to be only sixty feet. The gentleman alluded to, mentions, at thirty-five minutes after twelve, they heard three distinct noises, like the discharge of cannons, in the subterraneous caverns whence the spring issues, which were followed by a trembling of the earth and an immediate rise and fall of the water in the bason. At eight minutes after two the water flowed over the border of the bason; at fifteen minutes after three several subterraneous noises were heard, but not so loud as the first; at forty-three minutes after four the water rushed violently over the edge of the bason for about a minute; at forty-nine minutes after the last named hour, many loud explosions were heard, as if near the source of the spring, and the ridges of rocks in the vicinity; after this great effort the water became comparatively quiet.

The impelling power within the earth is very great at Geyser, and is sufficiently so to prevent stones from sinking that are thrown into the aperture; on the contrary, the force of the water carries them up with it to a considerable height. We shall conclude our account of these Icelandic springs in the words of the Doctor. "When the bason was full of water, we placed ourselves before the sun in such a manner, that we could see our shadows in the water, every one observed round the shadow of his own head, though not round the heads of others, a circle of almost the same colours which compose the rainbow, and round this another bright circle: this most probably proceeded from the vapours exhaling from the water. I remember to have seen something similar to it when travelling in the summer, particularly in the meadows. Not far from this place, another spring, at the foot of the neighbouring ridge of rocks, spouted water to the height of one or two yards each time." The gentlemen present thought it possible to close the mouth of this huer with stones, and made the experiment, but the water removed the whole from the aperture, and threw them in a circle round it, afterwards gushing forth with its original freedom.

The waters of these large springs were violently heated, and seemed slightly impregnated with sulphur, though perfectly clear and pure in other respects; some others, less considerable, near them, were thick and turgid, as if mixed with clay. A third class presented the fluid as white as milk, and a few force their way through the earth, heated to a red glow. Near most of the springs are baths, frequented by the natives, some of which are dry, and for sweating. The vapour is collected into those through fissures in the earth, and the thermometer rose from 57 to 93 on introducing it into the open hut used for this purpose.

As it is not our present intention to notice those heated springs which are impregnated with mineral substances, we shall refer to MINERAL WATERS for an account of them. The Island of Ceylon furnishes an instance of hot springs under the class of the huers of Iceland, except that no volcanic cause exists sufficiently near them to force the water out of the earth with violence. At Cannia, about six miles northwest of Trincomallee, are six wells, built of stone and mortar, in square and circular forms, generally about four feet deep, and less than two in circumference, which are inclosed by a stone wall six feet high, and contain the superior springs, though there are others in the neighbourhood in their natural state. In each the water is refreshing and pleasant to the taste, and air is continually rising to the surface in bubbles, accompanied by steam. The natives of the island, and of the adjacent coast of India, delight to bathe in this water, and seating themselves by the sides of the wells, they lade the warm fluid in earthern or brazen vessels, and pour it over their heads for hours together. Either imagination, or the inherent qualities of the water, produce benefit to those who use it in cases of strains, bruises, or rheumatisms; or possibly the warm bath may accomplish the cure, as it appears from the following analysis, made by Thomas Christie, Esq. surgeon of the 80th regiment, that there are very few proofs of the incorporation of mi-

neral substances with the water, which was inserted in the Madras Gazette, 1799, and subsequently in Mr. Cordiner's description of Ceylon, whence the above account of the springs was derived. "The hot-wells of Cannia are of different degrees of heat; they, however, evidently communicate, for the water in all of them is at an equal distance from the surface of the ground, and a body immersed in one, raises the height of the water in the others. As the water also from the six wells exhibits the same chemical phenomena, there can be little doubt that they all proceed from the same spring. On examining the heat of the different wells with great attention, it was found that they varied from 98° to 106° ½ of Fahrenheit's thermometer, nearly in proportion to their different depths. Bubbles of air are seen to rise from the bottom of the wells, and it was therefore conceived that the water might be acidulous, and impregnated with fixed air. It was found, however, that the water did not sparkle in a glass more than common water, nor did it turn a vegetable colour red; and on filling a large case bottle with the water, and tying an empty wet bladder to the mouth of it, it was found, after shaking a long time, that no air was disengaged. It would therefore appear that the water is not impregnated with any uncommon quantity of air; but that the bubbles are merely common air disengaged from the water by the heat. As the air, however, might be collected with a proper apparatus, its quality may be easily ascertained. The water has nothing peculiar in its colour, smell, or taste. It is not crude or hard, for it dissolves soap easily and perfectly. It contains no sulphurous principle, for a piece of polished silver, when immersed in it, contracted no rust nor dark colour. It contains no acid or alkali in a disengaged state, for on mixing a delicate vegetable colour with it, no change to a green or red colour was perceptible. The water does not contain any selenite, or earthy, or alkaline matter, combined with vitriolic acid, for on adding a solution of mercury in nitrous acid to it, no sediment was deposited, nor does it contain any earthy matter in combination with marine acid, nor any copper, nor zinc, for on mixing mineral and volatile alkalies with the water, no precipitate was formed. On mixture with a decoction of galls, the water acquired a blackish tinge, which shews it to be slightly impregnated with iron. On a mixture with a solution of silver in nitrous acid, some precipitate of luna cornea was produced; this shows it to contain a very small portion of sea-salt, but not more than the common water of Trincomallee, upon which the solution of silver had the same effect, with this difference, that the precipitate from the water of the hot-wells was blackest, probably from the impregnation of iron. These experiments were made at the wells, with water from those of the highest and of the lowest temperature, on the 4th of July, 1798, when the heat of the atmosphere was at 91 degrees. They were also repeated upon the water after it was brought to Trincomallee with the same effect. From them it would appear that the hot-wells of Cannia possess few mineral qualities, or indeed any virtue besides their heat, which is of a temperature not unfavourable for hot bathing. For many complaints also, the drinking of hot water is recommended, and for this purpose, as well as for bathing, a hot spring is preferable to water heated artificially, because it is always of a fixed degree of temperature."

It is extremely probable that an analysis of the water from the huers of Iceland, would produce nearly the same result, whence it may be safely concluded, that the water is suddenly heated in its passage through the fissures or caverns of the earth by its approach to volcanic fires, and that its properties are exactly the same with those of the springs which flow from the bases of hills in a perfectly cold state.

HUGONIA, in botany, so named in memory of Augustus Johannes de Hugo, a genus of the Monadelphia Decandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: five-styled; corolla five-petalled; drupe with a striated nut. There is but one species; *viz.* H. mystax, a native of the East Indies.

HUGUENOTS, a term of contempt, first given to the French protestants in the year 1560. The origin of this term is much involved in obscurity; and various attempts have been made to account for it, and for its application to the friends of the reformed church in France. Some suppose the appellation of Huguenots was derived from Huguon, a word used in Tourain, signifying persons that walk during the night season in the streets, and that it was applied to the French Protestants in consequence of their making choice of that season, in order to avoid persecution, in which to perform public worship. Others again, believe, that

this term owes its origin to the name of a supposed hobgoblin, called king Hugon, that was said to wander about the streets of Tours during the night-time, and that the reformed were the disciples of this nocturnal monarch. But the most probable conjecture seems to be, that this term owes its origin to an erroneous pronunciation by the French of the German word Eidgnossen, which signifies *sworn-fellows*, or *confederates*. This had been originally the name of that part of the inhabitants of Geneva who entered into an alliance with the Swiss cantons, in order to maintain their liberties against the tyrannical attempts of Charles III. Duke of Savoy. These valiant confederates were called Eignots, and from thence it is not at all unlikely was derived the word Huguenots.

To whatever cause this term owes its origin, it is certain that the Christians of the French Protestant churches, which it was made to designate, suffered most severely from the persecutions which at that time, and after the revocation of the edict of Nantes, raged with desolating fury both in France and other countries. The countenance and support of many princes of the royal blood, and of several of the nobility, could not save the Huguenots from suffering the most unparalleled persecution. Peace itself, which had been granted them by Henry III. in the year 1576, proved the foundation of a most terrible civil war. The profligate House of Guise, urged by the wicked and cruel suggestions of the Roman Pontiffs, did whatever lay in its power to destroy the royal family, and totally ruin the Protestant reformation; while the Huguenots, inspired with the spirit of loyalty, and a noble religious enthusiasm, fought in defence of their faith and their sovereigns with various success. The deeds of horror, which these commotions produced, are scarcely exceeded by any thing we find recorded in the annals of murder and persecution. The civil war to which we are here alluding raged nearly sixty years, during which there were destroyed, according to Puffendorf, a million of people: one hundred and fifty millions of money were spent: nine cities, four hundred villages, twenty thousand churches, two thousand monasteries, and ten thousand houses, were burnt or laid level with the ground. These terrible devastations were at length stopped by the hand of Providence, which placed Henry IV. on the throne of France. This prince, who, though he had so many outrages to avenge, so many crimes to punish, thought only of burying all animosity in oblivion, and of healing all wounds. Then absolute power was employed only in promoting prosperity in the state, and the felicity of every individual. The Roman Catholic religion remained dominant; but the famous edict of Nantes effaced intolerance, and soothed the irritation of the conquered party, to whom liberty of conscience and a political existence were secured.

The edict of Nantes confirmed to the Protestants all the favours that had ever been granted to them by Henry III. To these privileges others were also added; such as a free admission to all employments of trust, honour, and profit. These wise and politic regulations were perfectly satisfactory to good sense and equity: they were, however, not enough for fanaticism: it made several attempts on the saviour of France, and at length succeeded in assassinating him. From this melancholy day (May 14, 1610) the troubles of the Huguenots began to be renewed. Alarmed at the intrigues that were perpetually working against their rights and liberties, they again took up arms, but were successfully opposed by Richelieu. The government succeeded in rendering its authority absolute; and factions and discontents agitated and disturbed the two parties in no small degree. These discontents continued to increase until the reign of Louis XIV. This ambitious, weak, and credulous prince was persuaded wholly to revoke the edict of Nantes, which had been long openly violated. This was a deplorable epocha for the Huguenots. They were not only expelled the parliament, and deprived of all their civil and religious liberties; but multitudes of the most industrious families in France were reduced to beggary. They were harassed in all manner of ways. Eight hundred thousand persons (Voltaire says five hundred thousand) left the kingdom, and fled into other countries, where their descendants are still to be met with, and where they have carried prosperity to the prejudice of their own unjust country. Such of these unfortunate people as remained in France lost all civil existence, were pursued without remission, without pity, and like wild beasts; their blood frequently streamed under the steel of the executioner or of the soldiery. This last explosion, however, at length ceased. The unfortunate Louis the XVI. whatever were his weaknesses and failings in other respects, had not been rendered inhuman by a large

share of Catholicism; but laboured to heal all their wounds, when the storm arose, of which he was one of the first, and the most illustrious of the victims. It ought ever to be remembered, to the honour of this unhappy monarch, that he paid no attention to the intolerant and disgraceful "Memoire de l' Assemblée generale du clergé," in 1780, against the reformed. During his reign a law was past, which gave to his non-Roman Catholic subjects, as they were denominated, all the civil advantages and privileges of their Roman Catholic brethren. From that period the situation of the French protestants (for the obnoxious term Huguenots seems to have been almost laid aside) has been tolerably happy. But what seems to have given a stability and respectability to the French Protestants, are the decrees which have been passed in their favour by the present Emperor of France. On Sunday the 9th of August, 1807, the consistory of the Protestant church being admitted to an audience, their president, M. Marron, addressed the Emperor in a speech of considerable eloquence, in which he gratefully acknowledged his protection and care of them as a religious body; and declared that the roofs of their temples shall ever resound with praises for such signal favours as they enjoy under his auspices. His speech was answered in the most gracious and cordial manner. The following expressions in it are remarkable: "I accept the blessing and the congratulation of the consistory. You owe me no obligation; I wish not men to think themselves indebted to me, because I have been merely just. Conscience is not within the jurisdiction of human laws. I guarantee to you, for myself and my successors, not only the intendance, but also the perfect freedom and inviolability of your worship. The Protestants have always proved themselves to be good citizens, and faithful subjects of the law. Though I do not profess their religion, tell them that I place them in the circle of my best friends!"

Thus are the once despised and persecuted Huguenots raised from situations of suffering and wretchedness to that rank in society which is the unalienable right of every honest man, be his religious principles what they may.

HULK, in sea language, a name given to any old vessel laid by as unfit for service. In the royal ports they are used for the accommodation of a ship's company while their own vessel is in dock under repair.

HULL, in the sea language, is the main body of a ship, without either masts, yards, sails, or rigging. Thus, to strike a hull in a storm is to take in her sails, and to lash the helm on the lee side of the ship; and to hull, or lie a hull, is said of a ship whose sails are thus taken in, and helm lashed a-lee.

HUMANITIES, in the plural, signify grammar, rhetoric, and poetry, known by the name of *literæ humaniores;* for teaching of which, there are professors in the universities of Scotland, called humanists.

HUMERUS, in anatomy, the upper part of the arm, between the scapula and elbow. See ANATOMY.

HUMIDITY. See HYGROMETER.

HUMMING *bird.* See TROCHILUS.

HUMULUS, *hops,* in botany, a genus of the Dioecia Pentandria class and order. Natural order of Scabridæ. Urticeæ, Jussieu. Essential character: male, calyx five-leaved; corolla none: female, calyx one-leafed, spreading obliquely, entire; corolla none; styles two; seed one, within a leafed calyx. There is but one species, *viz.* H. lupulus, HOPS, which see.

HURA, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, ament imbricated; perianth truncated; corolla none; filaments cylindrical, peltate at the tip, surrounded by very many anthers in pairs: female, calyx and corolla none; style funnel-form; stigma twelve-cleft; capsule twelve-celled; seed one. There is but one species, *viz.* H. crepitans, sand-box tree. This grows naturally in the Spanish West Indies, from whence it has been introduced into the British colonies of America, where some of the plants are preserved by way of curiosity. It is about twenty-four feet in height, dividing into many branches, which abound with a milky juice. The fruit is very curious in its structure; and the tree, when it grows well, is spreading, and sometimes casts a shade forty feet in diameter; from the quickness of its vegetation, its parts are of so loose a texture, that a loud clap of thunder, or a sudden gust of wind, frequently causes the largest boughs to snap asunder; the trunk is of little use, except for fire-wood.

HURDLES, in fortification, twigs of willows or osiers interwoven close together, sustained by long stakes, and usually laden with earth. Hurdles, called also clays, are made in the figure of a long square; the length being five or six feet, and the breadth three, or three and a half: the closer they

are woven, the better. They serve to render batteries firm, or to consolidate the passage over muddy ditches: or to cover traverses and lodgments, for the defence of the workmen, against the fire-works, or the stones that may be thrown against them.

Hurdles, in husbandry, certain frames, made either of split timber, or of hazel-rods wattled together, to serve for gates in inclosures, or to make sheepfolds, &c.

HURRICANE, a furious storm of wind, owing to a contrariety of winds. See article Wind and Whirlwind. Hurricanes are frequent in the West Indies, where they make terrible ravages, by rooting up trees, destroying houses and shipping, and the like. The natives, it is said, can foretell hurricanes by the following prognostics: 1. All hurricanes happen either on the day of the full, change, or quarter of the moon. 2. From the unusual redness of the sun, the great stillness, and at the same time, turbulence of the skies, swelling of the sea, and the like, happening at the change of the moon, they conclude there will be a hurricane next full-moon; and if the same signs be observed on the full moon, they may expect one next new moon. As to the cause of hurricanes, they undoubtedly arise from the violent struggle of two opposite winds. Now as the wind betwixt the tropics is generally easterly, and upon the sun's going back from the northern tropic, the western winds pour down with violence upon those parts, the opposition of these contrary winds cannot fail to produce a hurricane. Hurricanes shift not through all the points of the compass, but begin always with a north wind, veer to the east, and then cease; and their shifting between these two points is so sudden and violent, that it is impossible for any ship to veer with it; whence it happens that the sails are carried away, yards and all, and sometimes the masts themselves wreathed round like an osier.

HUSBAND and WIFE, usually termed baron and feme, are one person in law; that is, the very being or legal existence of the woman is suspended during the marriage; or, at least, is incorporated and consolidated into that of the husband, under whose wing, protection, and cover she performs every thing; she is therefore called, in our law, (French,) a feme covert, that is, under the protection and influence of her husband, her baron, or lord; and her condition, during her marriage, is called her coverture. A man cannot grant lands to his wife during the coverture, nor any estate or interest to her, nor enter into covenant with her; but he may, by his deed, covenant with others for her use, as for her jointure, or the like; and he may give to her, by devise or will, because the devise or will does not take effect till after his death.

All deeds executed by the wife, and acts done by her during her coverture, are void; except a fine, or the like matter of record, in which case she must be solely and secretly examined, that it may be known whether or not her act be voluntary. A wife is so much favoured, in respect of that power and authority which her husband has over her, that she shall not suffer any punishment for committing a bare theft, in company with, or by coercion of her husband; but if she commit a theft of her own voluntary act, or by the bare command of her husband, or be guilty of treason, murder, or robbery, in company with, or by coercion of her husband, she is punishable as much as if she were sole; because of the odiousness and dangerous consequence of these crimes. By marriage, the husband hath power over his wife's person; and the courts of law still permit a husband to restrain a wife of her liberty, in case of any gross misbehaviour; but if he threaten to kill her, &c., she may make him find surety of the peace, by suing a writ of *supplicavit* out of Chancery, or by preferring articles of the peace against him, in the court of King's Bench, or she may apply to the spiritual court for a divorce, on account of cruelty. The husband, by marriage, obtains a freehold in right of his wife, if he takes a woman to wife that is seized of a freehold; and he may make a lease thereof for twenty-one years, or three lives, if it be made according to the statute, 32 Henry VIII. c. 28. The husband also gains a chattel real, as a term for years, to dispose of, if he please, by grant or lease in her life-time, or by surviving her: otherwise it remains with the wife; and upon execution for the husband's debt, the sheriff may sell the term during the life of the wife. The husband also, by the marriage, hath an absolute gift of all chattels personal, in possession of the wife in her own right, whether he survives her or not. But if these chattels personal are choses in action, that is, things to be sued for by action, as debts by obligation, contract, or the like, the husband shall not have them, unless he and his wife recover them.

By custom in London, a wife may carry

on a separate trade; and as such, is liable to the statutes of bankruptcy, with respect to the goods in such separate trade, with which the husband cannot intermeddle. If the wife is indebted before marriage, the husband is bound afterwards to pay the debt, living with the wife; for he has adopted her and her circumstances together; but if the wife die, the husband shall not be charged for the debt of his wife after her death; if the creditor of the wife do not get judgment during the coverture.

The husband is bound to provide his wife necessaries, and if she contract for them, he is obliged to pay for them; but for any thing besides necessaries he is not chargeable: and also, if a wife elope, and live with another man, the husband is not chargeable even for necessaries; at least if the person who furnish them be sufficiently apprised of her elopement. A man having issue by his wife, born alive, shall be tenant by the courtesy of all the lands in fee-simple, or fee-tail general, of which she shall die seised; and after her death, he shall have all chattels real; as the term of the wife, or a lease for years of the wife, and all other chattels in possession; and also all such as are of a mixed nature (partly in possession and partly in action), as rents in arrear, incurred before the marriage or after; but things merely in action, as of a bond or obligation to the wife, he can only claim them as administrator to his wife, if he survive her. If the wife survive the husband, she shall have for her dower, the third part of all his freehold lands: so she shall have her term for years again, if he have not altered the property during his life: so also she shall have again all other chattels real and mixed; and so things in action, as debts, shall remain to her, if they were not received during the marriage: but if she elope from her husband, and go away with her adulterer, she shall lose her dower; unless her husband had willingly, without coercion ecclesiastical, been reconciled to her, and permitted her to cohabit with him.

HUSBAND, *ship's*, the owner, who takes the direction and management of a ship's concerns upon himself, the other owners paying him a commission for his trouble.

HUSBANDRY. See AGRICULTURE.

HUSO. See ACIPENSER.

HUSTINGS. This court is held before the Lord Mayor and Aldermen of London. Error or attaint lies there, of a judgment or false verdict in the Sheriff's court. Other cities and towns, as York, Lincoln, &c., also have had a court of the same name.

HYACINTH, in mineralogy, a species of the zircon genus: the colour is red which passes through various shades into orange yellow, and from the yellow it passes into greenish grey and greenish white. It occurs in grains and likewise crystallized: its specific gravity is from 4 to 4.6. Different specimens have been analyzed: one from the island of Ceylon contained:

Zircon	70
Silica	25
Oxide of iron	0.50
	95.50
Loss	4.50
	100

When exposed to the blow-pipe it loses its colour, but not its transparency: it is infusible, excepting with borax, which converts it into a white transparent glass. If exposed to heat made by oxygen gas, it melts into a greyish white glass bead. It is found chiefly in the sand at Ceylon, though some specimens have been obtained in various parts of the continent of Europe. It will take a fine polish, and when very pure is highly esteemed.

HYACINTHUS, in botany, *Hyacinth* or *Harebells*, a genus of the Hexandria Monogynia class and order. Natural order of Lilia Roy, or Liliaceæ. Asphodeli, Jussieu. Essential character: corolla bell-shaped, with three honied pores by the germ. There are seventeen species.

HYADES, in astronomy, seven stars in the bull's head, famous among the poets for the bringing of rain.

The principal of them is in the left eye, called by the Arabs, Aldebaran. See ALDEBARAN, and ASTRONOMY.

HYALITE, in mineralogy, a species of the flint genus. Colour yellow and greyish white: it occurs in thin crusts on other minerals, and has much resemblance to gum, and is nearly allied to opal.

HYBERNACULUM, in botany, that part of the plant which defends the embryo-herb from injuries during the severities of winter, hence the name, hybernaculum or winter quarters.

HYBLÆA. See PHALÆNA.

HYDNUN, in botany, a genus of the Cryptogamia Fungi. Generic character: a horizontal fungus, echinated beneath with awl shaped fibres. Linnæus has six species

of this fungus, five with stems, and one without; these chiefly grow on decaying wood.

HYDRA, in astronomy, a southern constellation imagined to represent a water-serpent. The number of stars in this constellation in Ptolemy's catalogue is twenty-five, and in the Britannic catalogue, sixty-eight.

HYDRA, *polypes*, in natural history, a genus of the Vermes Zoophyta class and order. Animal fixing itself by the base, linear, gelatinous, naked, contractile and furnished with setaceous tentacula or feelers; inhabiting fresh waters, and producing its deciduous offspring or eggs from the sides. There are five species. H. gelatinosa, minute, gelatinous, milk-white, cylindrical, with twelve tentacula shorter than the body: it inhabits Denmark, in clusters on the under side of Fuci. But on the viridis, the fusca, and the grisca the greater number of experiments have been made, by naturalists, to ascertain their true nature and very wonderful habits. They are generally found in ditches. Whoever has carefully examined these when the sun is very powerful, will find many little transparent lumps of the appearance of jelly, and size of a pea, and flatted upon one side. The same kind of substances are likewise to be met with on the under side of the leaves of plants that grow in such places. These are the polypes in a quiescent state, and apparently inanimate. They are generally fixed by one end to some solid substance, with a large opening, which is the mouth; at the other, having several arms fixed round it, projecting as rays from the centre. They are slender, pellucid, and capable of contracting themselves into a very small compass, or of extending to a considerable length. The arms are capable of the same contraction and expansion as the body, and with these they lay hold of minute worms and insects, bringing them to the mouth, and swallowing them. The indigestible parts are again thrown out by the mouth. The green polype was that first discovered by M. Trembley: and the first appearances of spontaneous motion were perceived in its arms, which it can contract, expand, and twist about in various directions. On the first appearance of danger they contract to such a degree, that they appear little longer than a grain of sand, of a fine green colour, the arms disappearing entirely. Soon afterwards, he found the grisca, and afterwards the fusca. The bodies of the viridis and grisca diminish almost insensibly from the anterior to the posterior extremity; but the fusca is for the most part of an equal size, for two thirds of its length, from the anterior to the posterior extremities, from which it becomes abruptly smaller, and then continues of a regular size to the end. These three kinds have at least six, and at most twelve or thirteen arms. They can contract themselves till their bodies do not exceed one fourth of an inch in length, and they can stop at any intermediate degree of expansion or contraction. They are of various sizes, from an inch to an inch and a half long. Their arms are seldom longer than their bodies, though some have them an inch, and some even eight inches long. The thickness of their bodies decreases as they extend themselves, and vice versa; and they may be made to contract themselves either by agitating the water in which they are contained, or by touching the animals themselves. When taken out of the water they all contract so much, that they appear only like a little lump of jelly. They can contract or expand one arm, or any number of arms, independently of the rest; and they can likewise bend their bodies or arms in all possible directions. They can also dilate or contract their bodies in various places, and sometimes appear thick set with folds, which, when carelessly viewed, appear like rings. Their progressive motion is performed by that power, which they have of contracting and dilating their bodies. When about to move, they bend down their heads and arms, lay hold by means of them on some other substance to which they design to fasten themselves; then they loosen their tail, and draw it towards the head; then either fix it in that place, or stretching forward their head as before, repeat the same operation. They ascend or descend at pleasure in this manner upon aquatic plants, or upon the sides of the vessel in which they are kept; they sometimes hang by the tail from the surface of the water, or sometimes by one of the arms; and they can walk with ease upon the surface of the water. On examining the tail with a microscope, a small part of it will be found to be dry above the surface of the water; and, as it were in a little concave space, of which the tail forms the bottom; so that it seems to be suspended on the surface of the water on the same principle that a small pin or needle is made to swim. When a polype, there-

fore, means to pass from the sides of the glass to the surface of the water, it has only to put that part out of the water by which it is to be supported, and to give it time to dry, which it always does upon these occasions; and they attach themselves so firmly by the tail to aquatic plants, stones, &c. that they cannot be easily disengaged: they often further strengthen these attachments by means of one or two of their arms, which serve as a kind of anchors for fixing them to the adjacent substances.

The fusca has the longest arms, and makes use of the most curious manœuvres to seize its prey. They are best viewed in a glass seven or eight inches deep, when their arms commonly hang down to the bottom. When this or any other kind is hungry, it spreads its arms in a kind of circle to a considerable extent, inclosing in this, as in a net, every insect which has the misfortune to come within the circumference. While the animal is contracted by seizing its prey, the arms are observed to swell like the muscles of the human body when in action. Though no appearance of eyes can be observed in the polype, they certainly have some knowledge of the approach of their prey, and show the greatest attention to it as soon as it comes near them. It seizes a worm the moment it is touched by one of the arms; and in conveying it to the mouth, it frequently twists the arm into a spiral like a cork-screw, by which means the insect is brought to the mouth in a much shorter time than otherwise it would be; and so soon are the insects on which the polypes feed killed by them, that M. Fontana thinks they must contain the most powerful kind of poison; for the lips scarcely touch the animal when it expires, though there cannot be any wound perceived on it when dead. The worm, when swallowed, appears sometimes single, sometimes double, according to circumstances. When full, the polype contracts itself, hangs down as in a kind of stupor, but extends again in proportion as the food is digested, and the excrementitious part is discharged. The manner in which the polypes generate is most perceptible in the grisca and fusca, as being considerably larger than the viridis. If we examine one of them in summer, when the animals are most active, and prepared for propagation, some small tubercles will be found proceeding from its sides, which constantly increase in bulk, until at last in two or three days they assume the figure of small polypes. When they first begin to shoot, the excrescence becomes pointed, assuming a conical figure, and deeper colour than the rest of the body. In a short time it becomes truncated, and then cylindrical, after which the arms begin to shoot from the anterior end. The tail adheres to the body of the parent animal, but gradually grows smaller, until at last it adheres only by a point, and is then ready to be separated. When this is the case, both the mother and young ones fix themselves to the sides of the glass, and are separated from each other by a sudden jerk. The time requisite for the formation of the young ones is very different, according to the warmth of the weather, and the nature of the food eaten by the mother. Sometimes they are fully formed, and ready to drop off in twenty-four hours; in other cases, when the weather is cold, fifteen days have been requisite for bringing them to perfection. The polypes produce young ones indiscriminately from all parts of their bodies, and five or six young ones have frequently been produced at once; nay, M. Trembley has observed nine or ten produced at the same time. Nothing like copulation among these creatures was ever observed by M. Trembley, though for two years he had thousands of them under his inspection.

When a polype is cut transversely, or longitudinally, into two or three parts, each part in a short time becomes a perfect animal; and so great is this prolific power, that a new animal will be produced even from a small portion of the skin of the old one. If the young ones be mutilated while they grow upon the parent, the parts so cut off will be reproduced; and the same property belongs to the parent. A truncated portion will send forth young ones before it has acquired a new head and tail of its own, and sometimes the head of the young one supplies the place of that which should have grown out of the old one. If we slit a polype longitudinally through the head to the middle of the body, we shall have one formed with two heads; and by again slitting these in the same manner, we may form one with as many heads as we please. A still more surprizing property of these animals is, that they may be grafted together. If the truncated portions of a polype be placed end to end, and gently pushed together, they will unite into a single one. The two

portions are first joined together by a slender neck, which gradually fills up and disappears, the food passing from one part into the other; and thus we may form polypes, not only from different portions of the same animal, but from those of different animals. We may fix the head of one to the body of another, and the compound animal will grow, eat and multiply, as if it had never been divided. By pushing the body of one into the mouth of another, so far that their heads may be brought into contact, and kept in that situation for some time, they will at last unite into one animal, only having double the usual number of arms. The hydra fusca may be turned inside out like a glove, at the same time that it continues to eat and live as before. The lining of the stomach now forms the outer skin, and the former epidermis constitutes the lining of the stomach. See Adams on the Microscope.

HYDRACHNA, a genus of insects of the order Coleoptera. Head, thorax, and abdomen united; two feelers, jointed; from two to six eyes; eight legs, ciliate and formed for swimming. The insects of this genus are inhabitants of the water, and swim with considerable swiftness: they prey on the larva of Tipulæ, and Monoculi: the eggs are red and at first spherical, but afterwards become semi-lunar; larva six-footed and furnished with a singular proboscis. There are about fifty species. H. geographica, so called from the fancied map-like distribution of its variegations. It is one of the largest of the genus, and is occasionally seen in the clear ponds, and other stagnant waters. This is reckoned one of the most beautiful of the British insects.

HYDRANGEA, in botany, a genus of the Decandria Digynia class and order. Natural order of Succulentæ. Saxifragæ, Jussieu. Essential character: capsule two-celled, two beaked, containing many seeds; corolla five petalled; calyx, five-cleft, superior. There are three species.

HYDRARGYRUM, an old name given to mercury.

HYDRASTIS, in botany, a genus of the Polyandria Polygynia class and order. Natural order of Ranunculaceæ, Jussieu. Essential character: calyx none; petals three; nectary none; berry composed of one seeded acini, or granulations. There is but one species, *viz.* H. canadensis, Canadian yellow rost.

HYDRATE, in chemistry, lately introduced by Proust to express the chemical union of water with any substance, and especially with certain metallic oxides. The hydrate of copper is a blue-green oxide of this metal, which differs from the brown oxide, only in containing a large quantity of water, which a low red heat will expel.

HYDRAULICS teach us to ascertain the velocity and impetus of fluids when in motion, and serve as the basis for computing the powers of various machinery acted upon by running water.

The first principle we shall inculcate in this service is, that water being an inelastic fluid, (though many have thrown away much time in the attempt to prove the contrary,) can only be set in motion by two causes: *viz.* the increased pressure of the air, as in the air-vessels of fire-engines, and by gravitation; that is, where it is liberated from confinement, and allowed to descend to an inferior level. In the former case, water may be made to rise by machinery suited to the purpose; in the latter, it will inviolably seek a lower situation.

The velocity of water, proceeding through a hole in the side of a vessel, is ever proportioned to the distance of the aperture from the level of the fluid, the square root of the intermediate space being the guide. It must, however, be recollected, that in consequence of the decrease of that space, as the water is let out, the pressure becomes gradually less; therefore the medium, or mean distance, between the surface and the vent whence the water issues, will be found, in general, a correct standard. Hence we see, that, in order to force double the quantity of water through the lowest of two apertures, the distance must be quadrupled. For if a hole made at C in the pipe A B, fig. 1, will supply one gallon of water in a minute; to draw double that quantity in the same time, the lower hole, D, must measure from the surface, B, four times as much as from C to the surface.

This establishes the above position, and proves besides, that the force is equal to the velocity, as indeed we know to result in every branch of mechanism. To shew this, let the pipe, A B, be perforated in several parts, as at C D E; the first, *i. e.* C, being one foot; that at D being four feet; and that at E being seven feet below the surface, B; between E and A we will suppose only one foot interval, so that D may be in the centre of the height, A B. Draw the horizontal line, A F, and from D describe the semi-circle, B G A, having D G equal

to D A, or D B, for its radius. Now the water will, as it flows from D, describe a parabola, and will fall upon the line, A F, at such a distance from A, as will be equal to double the radius, D G. In like manner the water flowing from the aperture, C, will reach that point, *viz.* K, on the horizontal A F, which may measure double the sine, C H, on the same semicircle: and the sine of the arc taken opposite to E, *i. e.* E L, is equal to the sine, C H, the water rushing from E will intersect, or meet, the water falling from C, at the point K. It is to be observed, that the parabolic curve of the water proceeding from C to K, has a greater tendency to gravitation than that issuing from E, which rushes with far more force, and consequently has a greater tendency to an horizontal direction. For the aperture at C is only acted upon by a column of one foot deep, *i. e.* from B to C, but the column of water from B to E measures seven feet. We have already stated, that the velocity is equal to the square root of the column's height above the aperture.

It is the peculiar property of fluids to preserve their level, notwithstanding any varieties of course, or inequality of elevation. Thus, supposing the pipe, A B C D, fig. 2, to be bent into the form required for passing over declivities, as shown: the water will rise to the height, A D; but where the channel exceeds the level of that line, there will be a break in the course of the fluid, such as appears at B: yet the course may descend to any depth as at C, provided the pipe be brought back to the original height. If either end be in the smallest degree lower than the other, the water will sink to the level of the lower retaining brim. And if the supply be continual, the water issuing from the lowest end will mount nearly to the level of the source. This is the principle on which fountains are in general found. To effect this, however, the pipe should be small, so as to contract the issue of the fluid, and to give it greater velocity, by causing it to expose a smaller surface for the air to press upon. This contraction should not be carried to excess; else the water would want force to pass through the atmosphere, and, being subdued, would break into drops, and fall without gaining any height. The conduit-pipe is usually made about five diameters of the fountain-pipe; under such proportions the water will ordinarily flow so freely as to give a good jet.

The inelastic nature of water causes it to retain its surface perfectly level; were it otherwise, vessels would often run aground where, at present, they find depth sufficient to float them; and the whole body of a river would present a thousand opposing and unequal resistances; whereas we find the resistance to be uniform. To prove this, let a piece of wood be put into a pail of water, the fluid will in every part remain equally dense, and the surface will be perfectly level. For a further elucidation of this property, we refer to HYDROSTATICS, wherein it will be found very conspicuous.

The ingenious Mr. Bramah has lately applied the inelasticity of water to a variety of purposes, especially in the application of a power to remote effects. Thus, if water be filled into the pipe, A B C D, fig. 3, and that a piston be applied to A B, made perfectly tight, so that no water can possibly escape, when that piston is pressed down by means of a force capable of overcoming the friction of its sides, and the friction of the water within the tube, it will cause the water to rise in the pipe, C D, whatever may be the length of the conjunctive part, A C. Therefore, if a piston is inserted into the pipe, C D, it will be acted upon in perfect conformity with the motion of the piston in A B; the power to move which may be trifling, when the diameter of the pipe is small, and the purpose not relating to forcible operations. Thus, for the mere intention of ringing a bell at D, a hundred yards distant from the pull, A, a bore of less than a quarter of an inch in diameter would answer every purpose, and would yield to the pressure of the finger, with very little exertion. On the other hand, when machinery is to be set in motion, the size of the piston, and the force whereby it is to be moved, must be proportioned to the resistance generated by friction, and by the opposition to the action of the machine. It is necessary to observe, that where the two pistons are of equal diameter, their actions will be equal; but that if the pipe, A B, be larger than C D, it will produce an increased action in the latter, which, in such case, must have a proportionate increase of altitude, and, *vice versa*, when the action of A B is to be greater than that of C D. Our readers will be sensible that a tube of less diameter can be made to contain the same quantity as that of greater capacity, only by adding to its length; and that both their areas being filled and emptied alternately by the same

action, and in the same time, that which has the greatest altitude must have the greatest scope of action, and move with an increased velocity in exact ratio with the difference of the diameters. When the velocity of the machinery attached to the movement-tube is to be diminished, without losing the height to which the secondary power is thus raised by the additional length of the tube, the segment on which it is made to act must be that of a larger circle, as shewn in fig. 4, where the tube, A B, is of double the diameter of that at C D, which would raise the lever, E, to the height F. Now, if this lever were the handle of a pump, requiring a considerable exercise of power, it is evident the fulcrum, G, must be placed very near to the pump-tube, H; whereby the radius of the circle, G F, is greatly increased, and the plonge of the pump-piston, H, much diminished. If, on the contrary, the fulcrum had been at O, *i. e.* dividing the distance between D and X into three parts, of which two are given to the lever, N, the plonge would be far deeper, but the power would be greatly reduced; the segment, D F, occupying a greater angle with the fulcrum O, than it does with the fulcrum G. This is amply explained under the head of MECHANICS.

Where water is enclosed within a vessel, or in a tube, in such manner that air cannot penetrate, it will not flow out in the same manner as if air were admitted to supply the place of any quantity that might be required to be drawn off. Of this every person must be sensible who has ever attempted to draw wine, beer, &c. from a full cask, without opening a vent at the top, near the bung, to admit air, as the fluid might evacuate the upper part of the vessel. From this we prove, that although all fluids have a direct disposition to gravitation, they are perfectly inelastic, if they were otherwise, we should find that, by expansion, they would be capable of filling a greater or lesser space at times; and that as the wine, &c. were drawn off below, the portion remaining in the vessel would expand, and though less dense, would fill the whole interior.

Of this property advantage has been taken to draw off liquors from one vessel to another, by means of a very simple instrument, called a syphon. This is a pipe of tin, copper, &c. according to its purpose, bent at any angle, but generally about 70 to 80 degrees, in such manner that one limb may reach down through the bung-hole of the cask to be emptied, to its very bottom; the other leg should be the longest, so that when filled it may contain a heavier body of fluid than that limb within the vessel. See fig. 5, in which the syphon, A B C, is inserted into a vessel to be emptied. In large syphons it is necessary to insert a cock at the lower end to prevent the escape of the fluid when first filled. In small syphons it is common to put a small parallel tube, which being applied to the mouth, the end, C, being immersed in the liquor to be drawn off, the operator inhales forcibly, and by thus drawing the air out of the syphon, causes the liquor to rise in its place. The absence of air, which first caused the fluid to ascend into the tube, occasions it to remain until the finger is removed from the end, A; when the pressure of the air within the vessel causes the liquor to press through the syphon, which continues to the last to draw off the contents of the vessel, they pressing forward through the long end, A. It is proper to remark, that large syphons sometimes require to be previously filled, and then to be set in the vessels to be drawn off; but, in general, the casks, &c. can be tilted sufficiently to answer this purpose, and to bring the shorter limb nearer to a horizontal position than the longer limb, whereby the latter may possess a greater perpendicular altitude, and consequently a greater tendency to gravitation. For, we trust, that, in fig. 1, it has been demonstrated, that the pressure of a fluid is in proportion to its perpendicular height. We must caution the reader, that as a column of water of thirty-three feet in perpendicular height is equal to the weight of the atmosphere pressing on the surface of such a column, it follows that no syphon exceeding that length will act, because the power would be less than the weight to be raised.

A comical display of the properties of the syphon is seen in what is called "The Cup of Tantalus;" the designation of which is derived from fabulous history, wherein we are told, that Tantalus, king of Phrygia, was condemned by Jupiter to suffer perpetual hunger and thirst, amidst a profusion of delicacies, which always receded when applied to his lip. To imitate this disappointment, a syphon, having its two limbs parallel and contiguous, is fixed into the middle of a cup double its height; one limb receiving the liquid at the bottom of the interior, and the other discharging it

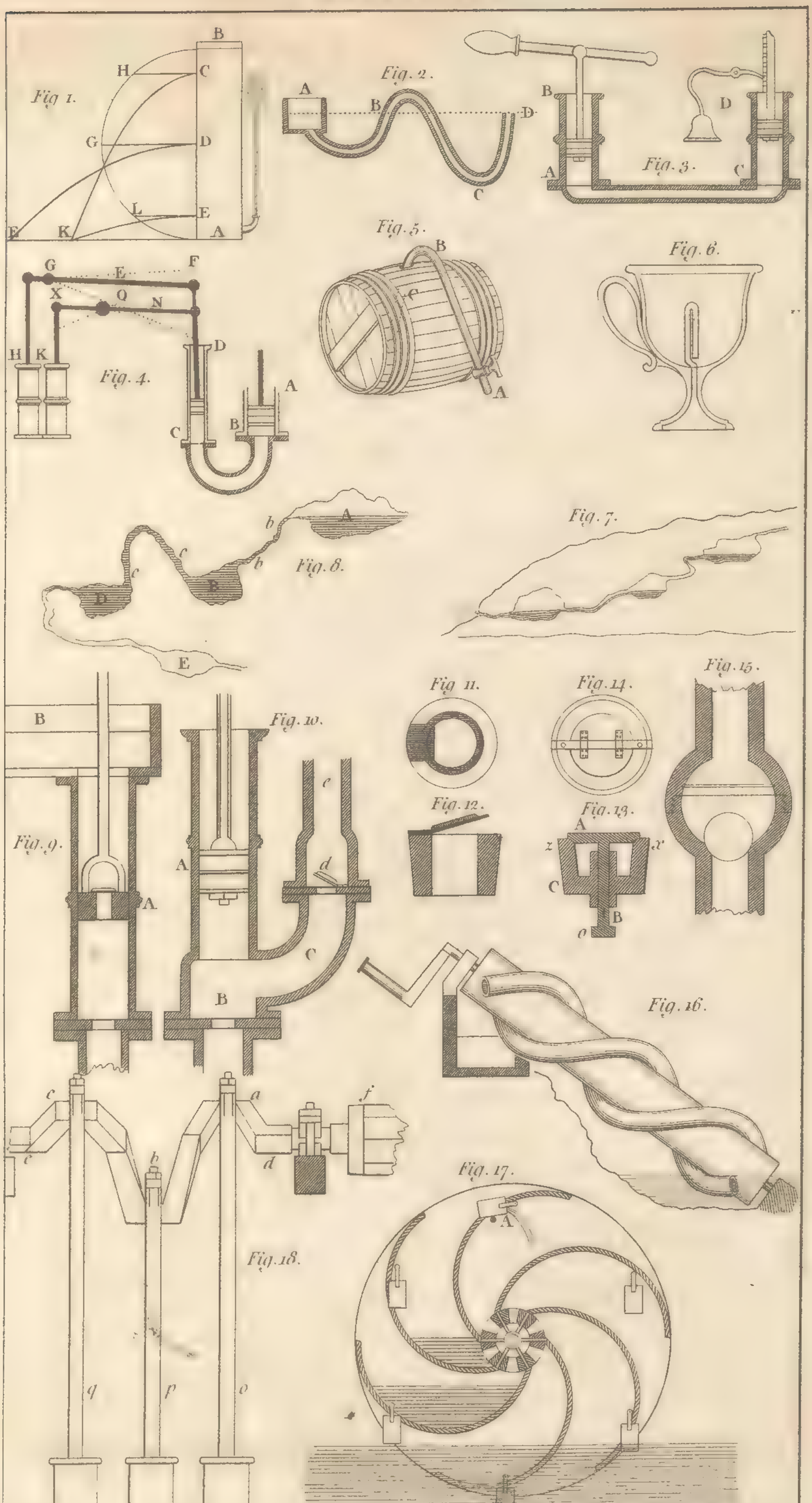
through the centre of the bottom, as seen in fig. 6. Thus, when the outlet is stopped by means of a finger applied thereto, the cup may be offered, quite full, to the person on whom the joke is to be practiced, observing that the syphon will not act until the liquor in the cup exceeds the level of its bend, when the whole will be drawn through the tube. This whimsical contrivance is rendered yet more diverting by having the syphon so contrived, that its action may commence only when the cup is inclined a little, as is usual when a person is about to drink; and if only a small flower, &c. be at the bottom of thevessel, appearing merely as an ornament, but allowing the liquor to pass under its petals, &c. into a tube made through one of two handles, and brought under the bottom.

Many springs are derived from natural syphons, existing in the sides of mountains, &c. at various depths, and to various extents. Some springs, situated on the tops of hills, near to larger ones, supply water all the year, others only periodically; when they usually flow in profusion. In either case the ignorant multitude rarely attribute the supply to the proper cause. We shall demonstrate from whence it originates.

When various caverns, in which water is either pent up or received, lay in a regular descent, one below the other, the water will naturally pass from one to the other, and cause a regular flow, more or less abundant, according as the source may be more or less abundantly supplied. If the soil through which it passes be close and retentive, the water will then be occasionally raised, as well as lowered, in proportion to the weight of the incumbent fluid, and will rise, if so guided by the channel through which it passes, even to the height of the source, as may be proved by what has already been shewn in fig. 2. Thus, after various changes of altitude, the fluid may escape at any height not above that source; or it may be carried away to any depth. The place where it issues forth is called a spring. Fig. 7, exhibits such a current, which we will suppose to have a perpetual supply.

But the intermitting spring may also have a regular supply. This is occasioned by the existence of caverns connected by syphons, as we may see by reference to fig. 8, where A is the source, *b b* the channel; B is a cavern, which by means of the arch, or rising channel, *c c*, becomes a syphon leading ing into D. It is obvious that, in the first instance, the water must, after filling B, rise in the channel, *b b*, as to be above the greatest height of *c c*, to cause its passing off into E, and thence *ad libitum*. Now the channel, *c c*, being of greater diameter than the channel, *b b*, when the former commences its operation, it will discharge more than the latter can supply, so as to keep up the discharge from *c c*; therefore, after B has been exhausted so far as to allow air to pass from it into *c c*, a certain quantity in that channel, which has not gained the summit, will recede into B, and the water must again rise to the height in *b b*, which shall cause it to flow over the summit of *c c*, before the spring can again appear to be supplied. Yet the flow from the source was never diminished.

The existence, or otherwise, of a vacuum, or void space, was long agitated, and that too with no small degree of acrimony, among the philosophers of old; and we may say of a date by no means ancient. Common sense should have told us, what experience so amply proves, that where one body or element retires, another must supply its place, else the whole creation would inevitably be torn asunder. It is, indeed, well known, that the elasticity of the air, which could be rarified *ad infinitum*, if we had the means of effecting the process, enables it to occupy large spaces on emergency, or to contract within the narrowest bounds. See PNEUMATICS. Under ordinary circumstances, however, we consider the air as being of a particular standard, namely, that a column ascending to the summit of our atmosphere, corresponds in weight with a column of water of thirty-three feet in height, allowing the bases, *i. e.* of the air, and of the water to be equal. Thus we find that where the air is withdrawn, by means of suckers, pistons, valves, &c. from within a pipe, of which the lowest part is immersed in the water contained in a well, &c. the fluid will rise to the height of thirty-three feet within the pipe, supplying the place of the air thus withdrawn. This is effected by the pressure of the atmosphere on the surface of the water; whereby it is forced into the space formerly occupied by the air. Generally speaking, it is not a sudden operation; for unless the well be very shallow, it will require many strokes of a pump to withdraw so much air as may so far rarify the residue, within the pipe, as to allow the water to rise thirty-three feet above its level. This is the greatest height to which water can be induced by a sucking pump.



J. Farey Jun. delin.

Lowry sculp

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In this contrivance the piston, A, see fig. 9, has a valve which, as the rod draws up, is closed by the pressure of the air above it; but in descending it opens, and allows the water, which had flowed into the lower part, whence the air was withdrawn, to rush through; as the piston is raised again, the weight of the water forcibly oppresses the valve, until it find a lateral passage at B, whence it issues, and in this manner any quantity may be raised. If the water has a direct issue, as in the common spouts of pumps, no further apparatus is wanted; but if it is to be retained, or pass through any other pipes more elevated than the debouchure, B, there must be a small angular projection, as shown by the dotted lines, to admit the valve C, also pointing upwards. In dry weather, or when the pump is not much used, the leather binding of the piston, as also the valves, will become dry; therefore it is necessary, on such occasions, to throw in a pail-full or two of water to moisten them; else the air will pass downwards as the piston rises, and prevent that exhaustion on which the ascent of the water depends. It is generally necessary to have a valve at the bottom of the pipe to keep in the water drawn into it, in order that the labour may be decreased; and that, if the pumping be intermitted, there may be less trouble in bringing up the water within reach of the piston.

Where the water lays near the surface, a *lifting-pump* may be used. This is nearly the same with the former; but requires the piston should be forced down beneath the level of the water in the well. In this it is not so indispensably necessary that the leather on the piston should fit so close: though it is the better for so doing. In the lifting-pump the whole depends on actually raising the water from the well as though it were done by means of a bucket; this occasions many to apply that designation to the piston. The same precautions are necessary if the water is to be passed into any pipe, as have been stated regarding the debouchure of the sucking-pump.

The forcing-pump has a solid piston, as seen at A in fig. 10, which, after the water has passed the valve at B, is pressed down, and causes the fluid to pass into the conducting pipe, C, where there is also a valve, *d*, to prevent its return. The valve at B closes as the piston descends, while that at *d* rises to allow its escape from the main pipe. When the piston rises, the water follows, as in the two former instances, through the lower valve B, while the smaller valve at *d* is also closed by the super-incumbent water in the conduit, *e*, and by the attraction of the piston, the water rushing after it to prevent a vacuum. In this kind of pump the piston must fit extremely close; both on account of the intended attraction of the fluid from below, and to prevent its escape upwards when the piston is pressed downwards.

The whole of those inventions which raise water by alternate risings and fallings of only one piston are subject to the inconvenience of having the water issue in jerks, which, in some instances, would prove highly inconvenient. To remedy this, a cistern should be placed near the debouchure, or spout, whence a small stream would flow with much less variation than from the spout itself. But the best mode of regulating the issue of water is by aid of an air-vessel, as in a fire-engine. See PNEUMATICS.

To detail all the varieties of pumps that are in use would be both beyond the limits of this work, and of no real utility to the reader: we shall therefore enter upon the description of the valves in general estimation, and then proceed to give a brief account of hydraulic machinery.

The most common kind of valve consists of a piece of stiff leather, such as is applied for soles in shoes, and is generally known by the name of pump-leather. On its upper side a piece of milled lead is rivetted firmly, and the part where it is to be fixed on the frame, or shell, of the piston, is grooved for the purpose of giving it pliancy, that it may work up and down as if on a hinge. Fig. 11, shows the plan; and fig. 12, the profile of this valve, which is cheap, simple, and easily repaired, though it has the defect of being liable to choke, and of not rising high enough to allow a sufficient passage for the water.

Fig. 13, shows a *button-valve*, which is merely a piece of turned metal, A, having a shank, B, of about eight inches or a foot in length, according to the depth of the block, *x z*. The shank passes through the bar, C, at the bottom of the block, and is prevented from coming up too high by the stud, or nut, *o*, at its bottom. When the water rises, it forces up the button, A, and passes through the hollow in the block, of which the superior part is expanded so as to fit the button, which being the frustrum of a cone, necessarily fits close into the expanded part as the water presses it, after having passed upwards in consequence of the descent of

the piston; which may either be solid, as in a forcing-pump, or valved, as in a lifting or a sucking pump. This valve may be applied to a piston, as well as to that part of the pipe which retains the water, that it may be within reach of the piston's action. An improvement has been made to this valve, by adding a ball of some weight to the bottom of the shank, B, and excavating the button, in order to reduce its weight in proportion: this insures the regular descent of the button to its seat.

The *butterfly-valve*, exhibited in fig. 14, varies from the two former, in having two semicircular flaps appended by hinges to a bar passing over the centre of the excavated piston. This valve is peculiarly eligible, because if one part should be stiff, and adhere to the piston, the other will play with an increased effect, though not equal to the action of both valves.

The simplest valve with which we are acquainted is the sphere, which is made of metal, and fits into a semi-spherical cavity on the top of the piston or block. When the piston (if it be on that) rises, the sphere falls into the socket; but when the piston is depressed, the rush of water from below forces the sphere upwards. The only inconvenience attendant upon this valve, which is shown at fig. 15, is, that its diameter being nearly equal to that of the bore, leaves a very narrow passage for the water. This, however, might perhaps be obviated, by making an excavation in the pipe, as shown by the dotted lines, and by driving nails through to obstruct the ball from rising too high.

These are the general principles of the valves in common use; though we could enumerate a great variety, which have all been strongly recommended, but in practice proved very deficient. We shall therefore proceed with the detail of hydraulic machines, commencing with those which supply the place of pumps, by raising water to given heights. The most simple, and perhaps the most ancient, is the spiral pump of Archimedes. It consists of a cylinder of wood, about a foot in diameter, and of any length at pleasure: on this a leaden pipe of any bore is wound from the bottom to the top, spirally. When the bottom of the cylinder revolves in the water, (by means of a common winch handle at the top, and of a pintle in the centre of its base, which rests in a box or step for that purpose below) the reclined position, as shown in fig. 16, occasions the water to enter the bottom of the pipe, and to be carried by the revolutions of the cylinder completely up to the top, where it discharges into a vessel. This, however, raises but a small quantity, though the height may be indefinite: therefore, where such a machine is in use, it will be found eligible to have the whole cylinder covered with various pipes, like the bands in a rope, whereby the quantity of water raised would be proportionably increased, with very little addition of power: the greatest resistance would arise from the friction upon the supporting axis, especially the lower one under the surface. Some of these machines have been worked in strong running brooks, by means of water-boards, the same as the great wheels in undershot mills.

The *horn-drum*, so called from a number of segments passing from the circumference of a large flat cylinder to its centre, is an easy mode of raising water. The scoops, or mouths, by turns dip into the water, and as they rise cause it to pass up the horn, or segment, until it is discharged into a trough placed under the end of the axis, which is hollow, and has its pintle fastened to a cross, as seen in fig. 17. Such wheels usually work with water (or float) boards; and some of them have projecting fins, from which rectangular buckets are suspended: these dip into the water as the wheel turns, and successively discharge into a trough, by means of a pin at A, which causes every bucket as it passes to turn to a horizontal instead of an erect position. The latter invention is ascribed to the Persians. The reader will, no doubt, readily perceive that a strong current, or other force, is needful to move machines so laden as the Persian wheel, it sometimes raising near a ton of water in each revolution; and that nothing but the necessity for raising water could induce to so great a loss of power. When treating of MILLS and of PUMPS, as also of PNEUMATICS, with which HYDRAULICS are often intimately blended, we shall enlarge more on this subject; for the present concluding with the ordinary mode of applying a water wheel to pumps, as may be seen at London Bridge, and in a great variety of instances, where immense quantities are raised by means of running water, referring to the article STEAM-ENGINE for the operations dependant on that power. We have, in speaking of FLUIDS, said much on their properties, which the reader will find both amusing and instructive: indeed we consider this doctrine to be indispensable, as

a study, with those who court an intimate acquaintance with hydraulics.

Fig. 18, shows the section of three forcing pumps, *o p q*, with their pistons, as acted upon by three cranks, *a b c*, each equally radiated from the branch *d e*, and moved by a water wheel, of which *f* is the axis: it is plain that the several cranks stand at an angle of 120 degrees respectively. By this means there is a counterbalance among them mutually, and each gives one stroke or plunge during each revolution of the wheel. If the wheel is large, it will of course move slowly; and, unless the pumps be very large, but little water will be raised: therefore it is usual to accelerate the motion of the branch bearing the cranks, by means of a spur, or of a trundle, turned by the water-wheel, and bearing such proportion thereto as the required increase of velocity may demand. For the manner of applying such a spur, &c. see the article MILL-WORK.

HYDRAULICON, *water organ*, in music, an instrument acted upon by water, the invention of which is said to be of higher antiquity than that of the wind organ.

HYDROCELE, in surgery, denotes any hernia arising from water, but is particularly used for such a one of the scrotum, which sometimes grows to the size of one's head, without pain, but exceeding troublesome to the patient. See SURGERY.

HYDROCEPHALUS, in surgery, a preternatural distention of the head to an uncommon size, by a stagnation and extravasation of the lymph, which, when collected within side of the bones of the cranium, the hydrocephalus is then termed internal; as it is external, when retained between the common integuments and the cranium. See MEDICINE.

HYDROCHARIS, in botany, a genus of the Dioecia Enneandria class and order. Natural order of Palmæ. Hydrocharides, Jussieu. Essential character: male, spathe two-leaved; calyx, trifid; corolla, three-petalled; filaments the three inner style bearing: female, calyx trifid; corolla three petalled; styles six; capsule six-celled, many seeded, inferior. There is but one species, with many varieties, *viz.* H. morsus ranæ, frog bit.

HYDROCOTYLE, in botany, *marsh pennywort*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: umbel simple, with a four-leaved involucre; petals entire; seeds semi-orbiculate, compressed. There are fifteen species.

HYDRODYNAMICS treat of the powers, forces, and velocities, of fluids in motion. Having entered fully into the detail of all relating thereto while treating of FLUID, HYDRAULICS, HYDROSTATICS, MILLS, and WATER *wheels*, we forbear from that repetition which would trespass on the space allotted to other articles, referring the reader to those heads for what appertains thereto.

HYDROGEN. It had been long known to the chemists, that a vapour or air is disengaged in some processes, which kindled on the approach of an ignited body. Van Helmont gave this the name of gas igneum, and it seems to have attracted the attention of Boyle, Mayow, and Hales. The chemists knew, that such a vapour or air was commonly disengaged during the solution of certain metals, in muriatic or dilute sulphuric acid, that it burnt at the mouth of the phial, and if mixed with atmospheric air, exploded when kindled by a match.

Mr. Cavendish, however, first examined its properties fully, shewed that it is permanently elastic, not absorbed by water, and that it is much lighter than atmospheric air. (Philos. Trans. vol. lvi. p. 141). This substance forming water when combined with oxygen, and being therefore the radical of that compound, the name hydrogen was given to it, at the formation of the new nomenclature.

It is always obtained from the decomposition of water, as it cannot, from other substances in which it exists, be easily disengaged in perfect purity. Some substance is made to act on water, which exerts an attraction to the oxygen, without combining with the hydrogen, when, of course, the hydrogen is disengaged, and passes into the elastic form.

At the common temperature of the globe, this decomposition cannot be effected with rapidity by any single affinity. Iron, moistened with water, decomposes it very slowly, and evolves hydrogen; but at the temperature of ignition, the decomposition is more rapid. If a coil of iron wire, or a quantity of iron filings be put into an iron or coated glass, or earthern tube, which is placed across a small furnace, and surrounded with burning fuel, so as to be brought to a red heat, on distilling water from a retort connected with it, the vapour, in passing over the surface of the ignited iron, is decom-

posed, the iron attracts its oxygen, and hydrogen gas issues from the extremity of the tube.

This process is a troublesome one, and by the agency of an acid, water is decomposed as rapidly by iron or zinc, at a natural temperature. Zinc affords the hydrogen in the greatest purity. One part of it, in small pieces, is put into a retort, or a bottle with a bent tube adapted to it; two parts of sulphuric acid, previously diluted with five times its weight of water, are poured upon it, an effervescence is immediately excited, hydrogen gas escapes, and is to be collected in jars filled with water, and placed on the shelf of the pneumatic trough. Its disengagement continues until the zinc is dissolved. Iron may be employed in place of zinc, but containing generally a little carbon, which is dissolved by the hydrogen, it affords a gas less pure. Muriatic acid serves the same purpose as sulphuric acid, but must be diluted with only twice or three times its weight of water.

In the experiment, the hydrogen gas is derived entirely from the decomposition of the water, the oxygen of which is attracted by the metal. That the acid suffers no decomposition, is proved by the liquor at the end of the experiment, being capable of saturating as much of an alkali as the quantity of acid employed would have done in a pure state. The agency of the acid was formerly explained, on the absurd doctrine of disposing affinity,—that it had no attraction to the pure metal, but to the oxide of the metal; that to satisfy this affinity, it caused the oxidation of the metal at the expence of the water, and then combined with the oxide thus formed. In conformity to Berthollet's speculations, it may be referred to the affinities of the acid to iron, and to oxygen, conspiring with the affinity of iron to oxygen: these, co-operating, produce a ternary combination, while the hydrogen gas is disengaged.

Hydrogen gas is permanently elastic. When collected over water, it is observed to have a peculiar smell, slightly fetid, which is not so perceptible when it is collected over quicksilver, and which is lost when the gas is exposed to substances which powerfully attract humidity. It is not the only substance in which water appears requisite to develope odour.

This is the lightest of the gases, and indeed the lightest substance whose gravity can be ascertained by weighing. Its specific gravity varies considerably, according to its state with regard to humidity. When it has been transmitted through water, or has remained for some time exposed to it, it is about ten times lighter than atmospheric air; when it has been received over quicksilver, and exposed to any substance which attracts water strongly, as quicklime, it is nearly 13 times lighter, or atmospheric air being 1,000, hydrogen is 84. Its specific gravity in this state, water being 1,000, is stated by Lavoisier at 0.0946. 100 cubic inches weigh 2.613 grains. It is from this levity, that it was applied with success to the construction of balloons; a varnished silk or linen bag, filled with it, having a specific gravity so much less than atmospheric air, as not only to rise in the atmosphere, but also to elevate an additional weight.

The chemical property by which hydrogen gas is most eminently distinguished, is its great inflammability. When an ignited body is approached to it, in contact with the atmosphere, it is immediately kindled, and continues to burn while the air is admitted; if previously mixed with atmospheric air, and a burning body approached to the mixture, or an electric spark sent through it, it instantly inflames with detonation; and when it has been mixed with oxygen gas, the detonation is more violent. When burning at the extremity of a capillary tube, on bringing a wide tube over the flame, a singular phenomenon, accidentally observed by Dr. Higgins, is produced, that of sounds of various tones, which vary in acuteness and strength, according to the width, the length of the tube, and the kind of substance of which it is formed, owing, apparently, as Picket and De la Rive have explained it, to the vibrations excited in the matter of the tube by the rapid expansion and condensation of the watery vapour near and around the flame, and which, regulated and equalized by regular reflections from the sides of the tube, constitute a musical sound. (Nicholson's Journal, 8vo. vol. i. p. 129; ibid, vol. iv. p. 23).

Though hydrogen gas be inflammable, it is incapable of supporting the combustion of other inflammables. If a burning body be quickly immersed in it, it is immediately extinguished.

This gas is incapable of supporting animal life by respiration; an animal immersed in it is soon killed. At the same time, it

does not appear to be so positively deleterious as the other noxious gases. Scheele long ago observed, that he was able to breathe it for twenty inspirations. (Treatise on Air and Fire, p. 160). Fontana shewed, what Scheele indeed had observed, that if the lungs were previously emptied as much as possible of atmospheric air, by a forcible expiration, it cannot be breathed so long, though still it did not appear to him to be positively deleterious, like some of the unrespirable gases, (Opuscules Physiques, p. 2). Rosier, even after expelling the air from the lungs, breathed hydrogen gas for several respirations; and Mr. Davy, in his experiments on the respiration of the gases, remarked, that in one experiment, after a complete exhaustion of the lungs, he found great difficulty in breathing hydrogen for half a minute, though in a subsequent experiment, with the same preparation, he breathed it for near a minute. The first six or seven inspirations produced no sensations whatever; in half a minute, a sense of oppression was felt at the breast, which increased until the pain of suffocation interrupted the experiment. (Chemical Researches, p. 400. 466). Hydrogen, therefore, is incapable of supporting life; the respiration of it can be continued only for a short time, and animals confined in it soon die. It appears only to prove fatal, not by a positively noxious quality, but by excluding atmospheric air, the due supply of which, by respiration, is indispensable to life. Blood exposed to it acquires a deep black colour, and the gas suffers a diminution of volume.

Hydrogen is not, as several of the other gases are, noxious to vegetable life; at the same time, it appears to contribute little to the nourishment of plants. Dr. Priestley having found, that it still continued inflammable after a growing vegetable had been confined in it for several months. It can apparently supply, to a certain extent, the place of light, in supporting vegetation. Von Humboldt observed, that some cryptogamic plants in mines, and of course secluded from light, were not pale, but of a green colour, such as they would have had from growing under exposure to the light of day; and he concluded, with sufficient probability, that the agency of light had, in this case, been supplied by the hydrogen gas, which is evolved in greater or less abundance in such situations.

Hydrogen gas is so sparingly soluble in water, that when agitated with it, it suffers no perceptible diminution of volume. When the water has been previously freed from atmospheric air, Mr. Henry found, that one hundred cubic inches take up 1.5 of the gas under a common atmospheric pressure; under increased pressure, a larger quantity, equal to one-third of the volume of the water, is absorbed.

The affinities of hydrogen seem principally exerted towards inflammable bodies. It unites with sulphur, phosphorus, and carbon, and forms gaseous compounds; it appears to be capable of dissolving even some of the metals, particularly iron, zinc, and arsenic. United with nitrogen, it forms one of the alkalies, ammonia; with oxygen, water. It is also a constituent principle of the greater number of the vegetable and animal products.

Hydrogen gas may be regarded as a product of some natural operations. It is found collected often in mines, derived probably from the decomposition of water by metals; it is known to the miners by the name of fire-damp, and is often the cause of accidents, from exploding on the approach of an ignited body. It is also extricated from stagnant water, and from marshy situations, from the slow decomposition of vegetable and animal substances holding, dissolved in it, carbon, and perhaps also phosphorus and nitrogen, and forming, as has been supposed with some probability, gases which render the air of such places unhealthy. From its levity, it has been supposed that the quantity of it thus produced at the surface of the earth, will rise through the atmosphere, and occupy the higher regions; and on its presence, some of the phenomena of meteorology, particularly the sudden appearance of some fiery meteors, have been supposed to depend. Its affinities have not been ascertained with any precision, as to their relative force.

HYDROGRAPHY, the art of measuring and describing the sea, rivers, lakes, and canals. With regard to the sea, it gives an account of its tides, counter-tides, soundings, bays, gulphs, creeks, &c.; as also of the rocks, shelves, sands, shallows, promontories, harbours, the distance and bearing of one port from another, with every thing that is remarkable, whether out at sea, or on the coast.

HYDROLEA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Convolvuli, Jussieu. Essential character: calyx five-leaved; corolla wheel-shaped; filaments cordate at the

base; capsule two-celled, two-valved. There are four species.

HYDROMANCY, a method of divination by water, practised by the ancients in this manner: they filled a cup or bowl of water; then fastening a ring to a piece of thread tied to their finger, held it over the water, and repeated a certain form of words, desiring to be satisfied with regard to their enquiry; and if the question was answered in the affirmative, the ring would strike the sides of the bowl of its own accord.

HYDROMETER. The best method of weighing equal quantities of corrosive volatile fluids, to determine their specific gravities, appears to consist in inclosing them in a bottle with a conical stopper, in the side of which stopper a fine mark is cut with a file. The fluid being poured into the bottle, it is easy to put in the stopper, because the redundant fluid escapes through the notch or mark, and may be carefully wiped off. Equal bulks of water and other fluids, are by this means weighed to a great degree of accuracy, care being taken to keep the temperature as equal as possible, by avoiding any contact of the bottle with the hand or otherwise. The bottle itself shows, with much precision, by a rise or fall of the liquid in the notch of the stopper, whether any such change has taken place. See Gravity, *specific*.

But as the operation of weighing requires considerable attention and steadiness, and also a good balance, the floating instrument called the hydrometer, has always been esteemed by philosophers, as well as men of business. It consists of a hollow ball, either of metal or glass, capable of floating in any known liquid; from the one side of the ball proceeds a stem, which terminates in a weight, and from the side diametrically opposite proceeds another stem, most commonly of an equal thickness throughout. The weight is so proportioned that the instrument may float with the last mentioned stem upright. In the less accurate hydrometer this stem is graduated, and serves to show the density of the fluid, by the depth to which it sinks; as the heavier fluids will buoy up the instrument more than such as are lighter. In this way, however, it is clear, that the stem must be comparatively thick, in order to possess any extensive range; for the weight of vitriolic ether is not equal to three-fourths of the same bulk of water, and therefore such an hydrometer, intended to exhibit the comparative densities of these fluids, must have its stem equal in bulk to more than one fourth of the whole instrument. If this bulk be given chiefly in thickness, the smaller differences of density will not be perceptible, and it cannot, with any convenience, be given in length.

To remedy this imperfection, various contrivances have been proposed, for the most part grounded on the consideration, that a change in the ballast, or weight employed to sink the ball, would so far change the instrument, that the same short range of gradations on a slender stem, which were employed to exhibit the densities of ardent spirit, might be employed in experiments upon water. Some have adjusted weights to be screwed upon the lower stem, and others, with more neatness and accuracy, have adjusted them to be slipped upon the extremity of the upper stem. But the method of Fahrenheit appears to be on all accounts the simplest and most accurate.

The hydrometer of Fahrenheit consists of a hollow ball, with a counterpoise below, and a very slender stem above, terminating in a small dish. The middle, or half length of the stem, is distinguished by a fine line across. In this instrument every division of the stem is rejected, and it is immersed in all experiments to the middle of the stem, by placing proper weights in the little dish above. Then as the part immersed is constantly of the same magnitude, and the whole weight of the hydrometer is known; this last weight, added to the weights in the dish, will be equal to the weight of fluid displaced by the instrument, as all writers on hydrostatics prove. And accordingly the specific gravities for the common form of the tables will be had by the proportion. As the whole weight of the hydrometer and its load, when adjusted in distilled water, is to the number 1,000, &c. so is the whole weight, when adjusted in any other fluid, to the number expressing its specific gravity.

In order to show the degree of accuracy an instrument of this kind is capable of, it may in the first place be observed, that the greatest impediment to its sensibility arises from the attraction or repulsion between the surface of the fluid and that of the stem. If the instrument be carefully wiped with a clean soft linen cloth, the metallic surface will be equally disposed to attract or repel the fluid. So that if it possess a tendency to descend, there will be a cavity surrounding the stem; or if, on the contrary, its ten-

dency be to rise, the fluid will stand round the stem in a small protuberance. The operator must assist this tendency by applying the pincers, with which he takes up his weights to the rim of the dish. It is very easy to know when the surface of the fluid is truly flat, by observing the reflected image of the window, or any other fit object seen near the stem in the fluid. In this way the adjustment of the weights in the dish may, without difficulty, be brought to the fiftieth part of a grain. If, therefore, the instrument displace one thousand grains of water, the result will be very true to four places of figures, or even to five. This will be as exact as most scales are capable of affording.

Some writers have spoken of the adjustment of an hydrometer of this kind, so that it shall at some certain temperature displace one thousand grains of water, as if this were a great difficulty. It is true, indeed, that the performance of a piece of workmanship of this nature would require both skill and judgment on the part of the artist; but it is by no means necessary.

Nothing more is required on the part of the workman, than that the hydrometer shall be light enough to float in ether, and capable of sustaining at least one-third of its own weight in the dish, without oversetting in a denser fluid. This last requisite is obtained by giving a due length to the stem beneath, to which the counterpoise is attached. With such an instrument, whatever may be its weight, or the quantity of water it displaces, the chemist may proceed to make his experiments, and deduce his specific gravities by the proportion before laid down. Or to save occasional computation, he may once for all make a table of the specific gravities, corresponding to every number of the load in the dish, from one grain up to the whole number of grains, so that by looking for the load in one column, he may always find the specific gravity in the column opposite.

This method is very ready and convenient in practice; but if it be preferred, the weights may be adjusted to the hydrometer, so as to show the specific gravity, without computation or reference. For this purpose the hydrometer must be properly counterpoised in distilled water, at the assumed standard temperature; suppose 60°, and the whole weight of the instrument and its load called 1.000, &c. Then the weight of the instrument and its load must be separately determined in grains and parts, or other weights, by a good pair of scales, and as the whole weight of the instrument and its load is proportioned to the weight of the instrument alone, so will be the number 1.000, &c. to a fourth term expressing the weight of the instrument in such parts as make the whole 1.000, &c. Make an actual set of decimal weights of which 1,000, &c. shall be equal to the hydrometer and its load; and it is clear, that whatever may be the load in these weights, if it be added to the number denoting the weight of the instrument, the sum will denote the specific gravity of the fluid, wherein the instrument floats with that load.

By following the above easy method, it will be found that every hydrometer, wheresoever made, must give the same results. The subject is indeed in itself sufficiently simple, and would require scarcely any discussion, if it had not happened that many philosophers, for want of requisite attention, have made their experiments with hydrometers graduated on the stem by no certain rule by which operators, at a distance from each other, might compare their experiments. The hydrometers, or pesé-liqueurs of Baumé, though in reality, comparable with each other, are subject, in part, to the defect, that their results, having no independent numerical measure, require explanation to those who do not know the instruments. Thus, for example, when a chemist acquaints us that a fluid indicated fourteen degrees of the pesé-liqueur of Baumé, we cannot usefully apply this result, unless we have some rule to deduce the correspondent specific gravity; whereas we should not have been in any respect at a loss, if the author had mentioned the specific gravity itself. As a considerable number of French philosophers refer to this instrument, it will be of use to explain its principles.

M. Baumé appears to have directed his attention chiefly to the acquisition of a means of making hydrometers with a graduated stem, which should correspond in their results, notwithstanding any differences in their balls or stems. There is little doubt but he was led into the method he adopted, by reflecting on that by which thermometers are usually graduated. See Thermometer.

As thermometers are graduated, independent of each other, by commencing with an interval between two stationary points of temperature, so M. Baumé adopted two determinate densities, for the sake of marking an interval on the stem of his hy-

drometer. These densities were those of pure water, and of water containing $\frac{15}{85}$ parts of its weight of pure dry common salt in solution. The temperature was ten degrees of Reaumur above freezing, or 54.5° of Fahrenheit. His instrument for salts was so balanced, as nearly to sink in pure water. When it was plunged in this saline solution, the stem arose in part above the surface. The elevated portion was assumed to be fifteen degrees, and he divided the rest of the stem with a pair of compasses into similar degrees.

It is unnecessary to inquire in this place, whether this interval be constant, or how far it may be varied by any difference in the purity, and more especially the degree of dryness of the salt. Neither will it be requisite to inquire how far the principle of measuring specific gravities by degrees, representing equal increments, or decrements, in the bulk of fluids, of equal weight, but different specific gravities, may be of value, or the contrary. It does not seem probable, that Baumé's instrument will ever become of general use, for which reason nothing further need be ascertained, than the specific gravities corresponding with its degrees, in order that such experiments as have this element among their data may be easily understood by chemical readers.

M. Baumé, in his "Elemens de Pharmacie," has given a table of the degrees of his hydrometer for spirits, indicated by different mixtures of alcohol and pure water, where, he says, the spirit made use of gave 37 degrees at the freezing point of water; and in a column of the table he states the bulk of this spirit, compared with that of an equal weight of water, as $35\frac{5}{8}$ to 30. The last proportion answers to a specific gravity of 0.842, very nearly. A mixture of two parts, by weight, of this spirit, with thirty of pure water, gave twelve degrees of the hydrometer at the freezing point. This mixture, therefore, contained $6\frac{1}{2}$ parts of Blagden's standard to 100 water; and by Gilpin's excellent tables, its specific gravity must have been 0.9915. By the same tables, these specific gravities of 0.842 and 0.9915 would, at 10° Reaumur, or 55° Fahrenheit, have fallen to 0.832 and 0.9905. Here then are two specific gravities of spirit corresponding with the degrees 12 and 37, whence the following table is constructed.

BAUME'S HYDROMETER FOR SPIRITS.

Temperature 55° Fahrenheit, or 10° Reaumur.

Deg.	Sp. Grav.	Deg.	Sp. Grav.
10 =	1.000	26 =	.892
11 =	.990	27 =	.886
12 =	.985	28 =	.880
13 =	.977	29 =	.874
14 =	.970	30 =	.868
15 =	.963	31 =	.862
16 =	.955	32 =	.857
17 =	.949	33 =	.852
18 =	.942	34 =	.847
19 =	.935	35 =	.842
20 =	.928	36 =	.837
21 =	.922	37 =	.832
22 =	.915	38 =	.827
23 =	.909	39 =	.822
24 =	.903	40 =	.817
25 =	.897		

With regard to the hydrometer for salts, the learned author of the first part of the "Encyclopédie, Guyton de Morveau," who by no means considers this an accurate instrument, affirms, that the sixty-sixth degree corresponds nearly with a specific gravity of 1.848; and as this number lies near the extreme of the scale, I shall use it to deduce the rest.

BAUME'S HYDROMETER FOR SALTS.

Temperature 55° Fahrenheit, or 10° Reaumur.

Deg.	Sp. Grav.	Deg.	Sp. Grav.
0 =	1.000	39 =	1.373
3 =	1.020	42 =	1.414
6 =	1.040	45 =	1.455
9 =	1.064	48 =	1.500
12 =	1.089	51 =	1.547
15 =	1.114	54 =	1.594
18 =	1.140	57 =	1.659
21 =	1.170	60 =	1.717
24 =	1.200	63 =	1.779
27 =	1.230	66 =	1.848
30 =	1.261	69 =	1.920
33 =	1.295	72 =	2.000
36 =	1.333		

It may not be amiss to add, however, that in the Philosophical Magazine, Mr. Bingley, the assay-master of the Mint, has given the following numbers as the specific gravity of nitric acid, found to answer to the degrees of an areometer of Baumé by actual trial; temperature about 60° Fahrenheit. But his appears to have been a

different instrument, as it was graduated only from 0 to 50°.

Deg.	Sp. Grav.	Deg.	Sp. Grav.
18	= 1.150	36	= 1.333
20	= 1.167	37	= 1.342
26	= 1.216	38	= 1.350
28	= 1.233	39	= 1.358
29	= 1.250	40	= 1.367
30	= 1.267	41	= 1.383
31	= 1.275	42	= 1.400
32	= 1.283	43	= 1.416
34	= 1.300	45	= 1.435
35	= 1.312		

One of the principal uses of the hydrometer in common life being to determine the specific gravity of vinous spirits on the mixtures of alcohol, which consist of water, an article of no value in a commercial light, and alcohol, which is of considerable price, it becomes of importance to determine how much of each may be contained in any mixture. The following tables, extracted from the large table of Gilpin in the "Philosophical Transactions," may be considered as of the first authority. They were made with mixtures of water and alcohol, of 0.825 at 60°. The alcohol was obtained from malt.

Real Specific Gravities of Spirits at different Temperatures.

Heat.	The pure spirit.	100 grains of spirit to 5 gr. of water.	100 grains of spirit to 10 gr. of water.	100 grains of spirit to 15 gr. of water.	100 grains of spirit to 20 gr. of water.	100 grains of spirit to 25 gr. of water.	100 grains of spirit to 30 gr. of water.	100 grains of spirit to 35 gr. of water.	100 grains of spirit to 40 gr. of water.	100 grains of spirit to 45 gr. of water.	100 grains of spirit to 50 gr. of water.
30°	.83896	.84995	.85957	.86825	.87585	.88282	.88921	.89511	.90054	.90558	.91023
35	83672	84769	85729	86587	87357	88059	88701	89294	89839	90345	90811
40	83445	84539	85507	86361	87134	87838	88481	89073	89617	90127	90596
45	83214	84310	85277	86131	86905	87613	88255	88849	89396	89909	90380
50	82977	84076	85042	85902	86676	87384	88030	88626	89174	89684	90160
55	82736	83834	84802	85664	86441	87150	87796	88393	88945	89458	89933
60	82500	83599	84568	85430	86208	86918	87569	88169	88720	89232	89707
65	82262	83362	84334	85193	85976	86686	87337	87938	88490	89006	89479
70	82023	83124	84092	84951	85736	86451	87105	87705	88254	88773	89252
75	81780	82878	83851	84710	85496	86212	86864	87466	88018	88538	89018
80	81530	82631	83603	84467	85248	85966	86622	87228	87776	88301	88781
85	81291	82396	83371	84243	85036	85757	86411	87021	87590	88120	88605
90	81044	82150	83126	84001	84797	85518	86172	86787	87360	87889	88376
95	80794	81900	82877	83753	84550	85272	85928	86542	87114	87654	88146
100	80548	81657	82639	83513	84308	85031	85688	86302	86879	87421	87915

Heat.	100 grains of spirit to 55 gr. of water.	100 grains of spirit to 60 gr. of water.	100 grains of spirit to 65 gr. of water.	100 grains of spirit to 70 gr. of water.	100 grains of spirit to 75 gr. of water.	100 grains of spirit to 80 gr. of water.	100 grains of spirit to 85 gr. of water.	100 grains of spirit to 90 gr. of water.	100 grains of spirit to 95 gr. of water.	100 grains of spirit to 100 gr. of water.
30°	.91449	.91847	.92217	.92563	.92889	.93191	.93474	.93741	.93991	.94222
35	91241	91640	92009	92355	92680	92986	93274	93541	93790	94025
40	91026	91428	91799	92151	92476	92783	93072	93341	93592	93827
45	90812	91211	91584	91937	92264	92570	92859	93131	93382	93621
50	90596	90997	91370	91723	92051	92358	92647	92919	93177	93419
55	90367	90768	91144	91502	91837	92145	92436	92707	92963	93208
60	90144	90549	90927	91287	91622	91933	92225	92499	92758	93002
65	89920	90328	90707	91066	91400	91715	92010	92283	92546	92794
70	89695	90104	90484	90847	91181	91493	91793	92069	92333	92580
75	89464	89872	90252	90617	90952	91270	91569	91849	92111	92364
80	89225	89639	90021	90385	90723	91046	91340	91622	91891	92142
85	89043	89460	89843	90209	90558	90882	91186	91465	91729	91969
90	88817	89230	89617	89988	90342	90668	90967	91248	91511	91751
95	88588	89003	89390	89763	90119	90443	90747	91029	91290	91531
100	88357	88769	89158	89536	89889	90215	90522	90805	91066	91310

Heat.	95 grains of spirit to 100 gr. of water.	90 grains of spirit to 100 gr. of water.	85 grains of spirit to 100 gr. of water.	80 grains of spirit to 100 gr. of water.	75 grains of spirit to 100 gr. of water.	70 grains of spirit to 100 gr. of water.	65 grains of spirit to 100 gr. of water.	60 grains of spirit to 100 gr. of water.	55 grains of spirit to 100 gr. of water.	50 grains of spirit to 100 gr. of water.
30°	.94447	.94675	.94920	.95173	.95429	.95681	.95944	.96209	.96470	.96719
35	94249	94484	94734	94988	95246	95502	95772	96048	96315	96579
40	94058	94295	94547	94802	95060	95328	95602	95879	96159	96434
45	93860	94096	94348	94605	94871	95143	95423	95705	95993	96280
50	93658	93897	94149	94414	94683	94958	95243	95534	95831	96126
55	93452	93696	93948	94213	94486	94767	95057	95357	95662	95966
60	93247	93493	93749	94018	94296	94579	94876	95181	95493	95804
65	93040	93285	93546	93822	94099	94388	94689	95000	95318	95635
70	92828	93076	93337	93616	93898	94193	94500	94813	95139	95469
75	92613	92865	93132	93413	93695	93989	94301	94623	94957	95292
80	92393	92646	92917	93201	93488	93785	94102	94431	94768	95111

Heat.	45 grains of spirit to 100 gr. of water.	40 grains of spirit to 100 gr. of water.	35 grains of spirit to 100 gr. of water.	30 grains of spirit to 100 gr. of water.	25 grains of spirit to 100 gr. of water.	20 grains of spirit to 100 gr. of water.	15 grains of spirit to 100 gr. of water.	10 grains of spirit to 100 gr. of water.	5 grains of spirit to 100 gr. of water.
30°	.96967	.97200	.97418	.97635	.97860	.98108	.98412	.98804	.99334
35	96840	97086	97319	97556	97801	98076	98397	98804	99344
40	96706	96967	97220	97472	97737	98033	98373	98795	99345
45	96563	96840	97110	97384	97666	97980	98338	98774	99338
50	96420	96708	96995	97284	97589	97920	98293	98745	99316
55	96272	96575	96877	97181	97500	97847	98239	98702	99284
60	96122	96437	96752	97074	97410	97771	98176	98654	99244
65	95962	96288	96620	96959	97309	97688	98106	98594	99194
70	95802	96143	96484	96836	97203	97596	98028	98527	99134
75	95638	95987	96344	96708	97086	97495	97943	98454	99066
80	95467	95826	96192	96568	96963	97385	97845	98367	98991

HYDROPHILUS, in natural history, a genus of insects of the order Coleoptera. Antennæ clavate, the club perfoliate; feelers four, filiform; the hind legs are formed for swimming, fringed on the inner side, and nearly unarmed with claws. The insects of this genus, like those of the Dytiscus, which see, are inhabitants of ponds and stagnant waters, where they swim with much dexterity, turning round with great velocity; they fly abroad by night in search of other waters. The males are distinguished from the females, by having a horny concave flap or shield on the fore legs, near the setting on of the feet; the hind legs are peculiarly fitted for their aquatic situation, being furnished on the inner side with a series of long and close-set filaments, resembling a fin, by which they are enabled to swim with great ease. The larva remain about two years and a half before they change into pupæ, forming a convenient cell, and secreting themselves in some bank. They are very voracious, and destructive to the more tender aquatic insects, worms, and young fish, which they seize with their forked jaws, and destroy by sucking out their juice. There are upwards of thirty species. The principal European species is the H. piceus, water-clock, which is not uncommon in our own country. The female of this species affords an example of a faculty, which seems to be exercised by no other insect of this order, *viz.* that of spinning a kind of web, or flattish circular case of silk, which it leaves floating on the water, and in which it deposits its eggs. This case, says Dr. Shaw, is terminated on its upper surface by a lengthened conical process, resembling a horn, of a brown colour, and of a much stronger nature than the case itself, which is white. The larvæ, as soon as hatched, make their escape from the envelopement

of the case, and commit themselves to the water.

HYDROPHOBIA, in medicine, an aversion or dread of water; a terrible symptom of the rabies canini. See MEDICINE.

HYDROPHYLAX, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: calyx four-parted; corolla funnel-form; fruit ancipital, one-seeded. There is only one species, *viz.* H. maritima, found in driving-sand, on the sea-shore, near Guduluhr in the East Indies.

HYDROPHYLLUM, in botany, *water-leaf*, a genus of the Pentandria Monogynia class and order. Natural order of Borragineæ, Jussieu. Essential character: corolla bell-shaped, having five longitudinal melliferous streaks on the inside; stigma bifid; capsule globular, two-valved. There are two species, *viz.* H. virginicum, Virginian water-leaf; and H. canadense, Canadian water-leaf.

HYDROSCOPE, an instrument anciently used for the measuring of time. The hydroscope was a kind of water-clock, consisting of a cylindrical tube, conical at bottom: the cylinder was graduated, or marked out with divisions, to which the top of the water, becoming successively contiguous, as it trickled out at the vertex of the cone, pointed out the hour.

HYDROSTATICAL *balance*, a kind of balance contrived for the easy and exact finding the specific gravities of bodies, both liquid and solid. See HYDROSTATICS.

HYDROSTATICS relate to the resting equilibrium of non-elastic fluids; and to the pressure of solids immersed therein. A fluid is a body whose parts are infinitely minute, capable of dislocation in consequence of the smallest force, invariably, (when suffered to rest), resuming a perfect level surface, and presenting an equal resistance, throughout every part to the body immersed.

Philosophers consider fluids to be divided into two classes, *viz.* the elastic, such as air, vapour, and gas; all which may be compressed more or less: and the inelastic, *viz.* water, mercury, spirits, &c. which cannot be compressed; though by being heated they distend considerably. It may be proper to observe in this place, that Mr. Canton in the years 1762 and 1764, published the results of experiments he had made, whereby it was endeavoured to be proved, that all fluids were compressible though in so trifling a degree as not to affect their bulks when under examination. With the barometer at $29\frac{1}{2}$, and the thermometer at 50, he declares the following compressions were effected.

	Spec. Grav.	Compression
With Spirit of wine	846	66 parts in a million
Oil of olives	918	48 ditto
Rain water	1,000	46 ditto
Sea water	1,028	40 ditto
Mercury	13,595	3 ditto

We leave the reader to judge whether it be probable by any apparatus of human formation, and under human guidance, to ascertain that the three millionth parts, said, to have been compressed, were really so. Indeed, even the sixty-sixth millionth parts, suffered to be compressed in the spirits of wine, must appear extremely doubtful; though we cannot but conclude that, as air exists in every atom of nature, more or less, with a sufficient force every fluid were subject to compression into a smaller space than is occupied by it when perfectly at liberty. Speaking generally, the definitions above given may be considered as applicable to all cases with which we are acquainted; and may, perhaps, be completely true.

We shall commence the detail, incident to this subject, with an account of the method of obtaining the specific gravities of bodies: that is, by shewing the comparative weights of various solids, and fluids, as ascertained by the most careful and skilful chemists. The reader must, however, consider the weights as taken at a medium. See GRAVITY, *specific*, where is given a table of specific gravities.

The reader will observe, that the whole of the above are compared with rain-water, which appear at 1,000 parts; but it is very remarkable that the density of that fluid varies greatly according to its temperature; and that it by no means affords a regular scale of weight, or of bulk in proportion to the degrees of heat. This will be seen

from the following table, taken from the observations of Dr. Blagden and Mr. Gilpin.

Degrees of Heat.	Bulk of the Water.	Specific Gravity.
30°		
35	99910	1.00090
40	99070	1.00094
45	99914	1.00086
50	99932	1.00068
55	99962	1.00038
60	100000	1.00000
65	100050	0.99950
70	100106	0.99894
75	100171	0.99830
80	100242	0.99759
85	100320	0.99681
90	100404	0.99598
95	100501	0.99502
100	100602	0.99402

We must suppose the water of the Dead Sea to be highly impregnated; since it appears to weigh nearly a fourth more than common sea water.

The anomalies lay between 32° and 45°, and are accounted for by the contraction which takes place in water about to freeze, and its sudden expansion afterwards: by this we understand the course of bottles, pitchers, &c. being burst when the water they contain freezes. The difference in bulk between water and liquors in the winter, and in the summer season, averages about three per cent: hence many great dealers have thought it worth their while to buy only in the former season, when the liquors have been most concentrated.

The specific gravity of a body either fluid, or solid, is ordinarily found by means of the hydrostatic balance; a most ingenious device for exactly ascertaining the weight, either immersed in the water, or in the air. The construction of this instrument requires peculiar nicety, but it may be appended to any common balance; as will be understood from the following description. Each scale should have a small hook fixed to the centre of its bottom, or lower side; so these small weights may be attached by means of horse-hair, or fine silk, thence to suspend a body in water without wetting the scale. First weigh the body in the usual manner in the scales, with great exactness; immerse it in water, and the equilibrium will be instantly destroyed. To restore it, put into the scale from which the body immersed in the water is suspended, as much weight as will bring it even with the other scale in which the opposing weight remains unaltered. The added weight will be equal to that of a quantity of water equalling the immersed body in bulk. Now if the weight of the body in air, be divided by what it weighed in the water, the quotient will show how much that body is heavier than its bulk of water.

A guinea, new from the Mint, will require 129 grains to be offered to its weight in air; but on being immersed in water, will require 7¼ grains more to restore the equilibrium lost by the immersion. From this we see, that a quantity of water equal in bulk with the guinea weight 7¼ grains, or 7.25, by which divide 129, (the weight in air), and the quotient will be 17.793; shewing that the guinea is as 17.793, to 1 of water.

But we sometimes have occasion to ascertain the precise weight of bodies that are lighter than water, say a piece of cork, and which if unaided, would float on its surface. In such case, it is necessary to affix a weight, (having previously found its exact poise) thereto; when by immersing both, and deducting the amount of the collateral weight, the residue will be left to account of the cork. If you would weigh quicksilver, it must be first balanced in a glass bucket, of which the weight is known, and which has been weighed also by immersion. When the bucket has been brought to equilibrium in the water, pour in the quicksilver, and the additional weight requisite to counterbalance it will show its exact weight.

Perhaps the following general rules for finding the specific gravity of bodies may prove useful and familiar to every understanding. 1. "When the body is heavier than water." Weigh it both in water, and in the atmosphere, and the difference between the results will shew the quantity lost in the former mode; then, as the weight lost in water, is to the weight in air; so is the gravity of water to the gravity of the body. 2. "When the body being specifically lighter, will not sink in water." Render the body heavy enough to sink by means of some appendage, as a small piece of lead, &c.; weigh the body and the appendage, both separately and together, in the air, and in the water: find out how much each loses in the water, and subtract those losses from the whole weight of each in air. Then, as the last remainder is to the weight of the light body in air;

so is the gravity of water to the gravity of the body. 3. "When a fluid is to be weighed." Weigh the fluid in a cup, which is to be deemed an appendage, and treated according to the foregoing rule, observing, that as the whole weight is to the loss of weight; so is the gravity of the solid to the gravity of the fluid.

We may ascertain the respective weights of two known ingredients in a given compound, thus: take the differences of every pair of the three specific gravities; (*viz.* the specific gravities of the compound, and of each ingredient): multiply each quantity by the difference of the other two; then, as the greatest product is to the whole weight of the compound; so is each of the other two products to each respective weight of the two ingredients.

If a piece of glass, or of metal, be immersed by suspension in different fluids, it will lose in weight; that is, it will require an equipoise, according to the weight of the fluids respectively: observing, that in the lightest fluid, say alcohol, it will lose least weight. This is the principle on which the hydrometer acts, as will be subsequently shown.

Vessels filled with water weigh more than when empty: to prove this, let a bottle be loaded so as to sink in a pail of water deep enough for the water to cover its mouth; which should be previously closed by a plug, in such manner as might be easily pushed in; append the bottle, in equilibrio, to the hydrostatic balance, and drive in the plug: the water will follow and destroy the equilibrium.

Fluids press every way alike, though their general tendency is to gravition. Thus if a vessel be made weaker in the side than at the bottom, and be so laden or oppressed, by the weight of water, as to burst the vessel, the weakest part, wherever situated, will become the outlet; but, so soon as liberated, the fluid will invariably descend; unless acted upon by a syphon, as shown in treating of hydraulics. The pressure upwards is, however, merely in conformity with circumstances attendant upon general pressure, and proves the tendency of fluids to find their own level. Thus if you take a glass tube of moderate diameter, open at both ends, and stop one closely with your finger; when you immerse the other end in any fluid, it will enter but little within the vacancy: because the columns of air within the tube represses it. But when the finger is withdrawn, the water will ascend within the tube, to the level of the body in which it is immersed.

As fluids press in all directions, it is evident their whole weight cannot be applied against one part or side; while on the other hand it is equally true, that, in some instances, the bottoms of vessels receive a pressure which does not appear to be their due. Thus, in a pan whose base is narrower than its brim, the bottom sustains only the weight of a column equal to its area, multiplied by its height; yet if the pan be of a bell-shape, having its base broader than its brim, the bottom will sustain a weight equal to its area also multiplied by its height. Consequently in a vessel of a conical form the base would be oppressed as much as if the sides were cylindrical. This is called the hydrostatic paradox; but will be easily reconciled by the consideration, that if a tube of glass be made with a curved bottom, so as to turn up in the form of the letter U, but with one leg or part much wider than the other, the water will rise equally in both. If to each a piston be fitted, their weights being equal, and that one piston be first put into the wider leg of the tube, it will cause the fluid to rise in the other in proportion to its weight; but on applying the lesser piston to the corresponding smaller tube, the two will be held in equilibrio. We have indeed further proof of the pressure of water upwards, by means of two boards, whose sides are joined by leather, as in a pair of bellows: these may be of any form or of any size. At the top of one of the boards cut a hole, and insert a tube of about four or five feet in length, so as to be perfectly tight: place on the board several weights, according to the size of the machine, and pour water into the tube. The upper board will bear up against the weights, provided they be not disproportionately heavy, and will admit the water between the top and bottom to the extent admitted by the pliable sides. Some water ought to be poured in before the weights are set on. A circle of about twenty inches in diameter will thus lift and support three weights, of 100 *lb.* each. Where either air or any other fluid is debarred from access between two planks annexed in the water, the lower one being kept to the bottom forcibly, they will not separate, unless a force equal to the weight of the superincumbent fluid be applied; because the lateral and superior parts of the fluid are prevented from exerting their pressure, except in that direction which keeps

the two planks together; but if the smallest opening be given, the pressure of the atmosphere will urge the fluid between them, and, by confining it to act as a wedge, force the upper one to the surface. The comparative weights of fluids are ascertained by the HYDROMETER, which see.

The comparative weight of fluids is given with the table of specific gravities, (see GRAVITY, *specific*); but it may be as well to point out in this place, that a gallon of proof spirit weighs 7 *lb.* 12 *oz.* avoirdupoise.

If a vessel contain two immiscible fluids (such as water and mercury), and a solid of some intermediate gravity be immersed under the surface of the lighter fluid, and float on the heavier, the part of the solid immersed in the latter will be to the whole solid as the difference between the specific gravities of the solid and of the lighter fluid is to the difference between the specific gravities of the two fluids. For a body immersed in a fluid will, when left to itself, sink, if its specific gravity be *greater* than that of the fluid; if *less* it will rise to the surface: if the gravities be equal, the body will remain in whatever part of the fluid it may be placed. But in the case adverted to, the one fluid being heavier and the other lighter than the body immersed, it is necessary to combine their gravities by the mode above shown.

Balloons are properly hydrostatic machines, and derive their property of ascending from the earth into the upper part of our atmosphere entirely to the difference between the specific gravity of the air, or gas, with which they are filled, and the exterior, or atmospheric, air in which they float. The weight of the materials must be taken into consideration; for unless the specific gravity of the interior be so much less than that of the exterior air, as to allow for the weight of the materials as a counterpoise, the balloon cannot be made to float even in a stationary manner; but when liberated will fall to the ground. The contents of the balloon being ascertained in cubic feet, it will be easy to ascertain what weight the balloon can lift when filled with rarified air, according as that may have been rendered more light than the atmospheric air: if filled with gas, the interior will be at least seven times lighter than an equal quantity of atmospheric air. From this it will be seen, that to bear up a weight of 300 *lb.* the balloon must be large, and the specific gravity of its contents be adequate to overcome the resistance of that impediment. As the air of the upper part of our atmosphere becomes gradually more rare, and consequently lighter, according to its distance from the earth's surface, we may conclude, that there is a point in its altitude beyond which a balloon could not soar; because its own weight, even if nothing were appended, would at such a point perfectly equipoise the difference between the confined gas and the surrounding atmosphere. And this is the more perfectly to be admitted, from the knowledge we have acquired of the difficulty with which balloons are made to reach certain heights; and of their ascent being shown (by the slower fall of the mercury within the barometer) to be far slower in the upper regions when they approach that state of equipoise. Were it not for the opposition offered by the superior air, a balloon would rise instantaneously from the moment of its liberation, in a most rapid manner, to that height where its equipoise should be found. We have said thus much in explanation of the nature of the balloon, as appertaining to the laws of hydrostatics, referring the reader to the article AEROSTATION, for whatever appertains to the practical experience we have had of that science, which at first seemed to promise the most important aid to various others, but in which it has completely failed: the whole of the principles on which aerostation depends have been long understood.

We shall now speak of the *diving-bell*, which also depends on hydrostatic principles, though, like the balloon, it has a close connection with pneumatics. The upper part of a diving-bell is always made to contain a certain quantity of air, more or less compressed in proportion to the depth to which the bell sinks. Thus, if we invert a small tumbler into a vessel nearly filled with water, and allow it to descend perpendicularly, so that no air may be allowed to escape, the water will rise a very little way within it. If the tumbler be but partially immersed, the water could at the utmost but rise to its own level; but if immersed so deep as to exceed its own interior, and that the bottom edge of the tumbler does not touch the bottom of the vessel, the water will, in consequence of its own greater weight at a greater depth, rise rather, though scarce perceptibly, higher in the tumbler, and occasion the air to be compressed into a smaller space. But the quantity of vital principle in the compressed air will be equal to that quantity of air in the

open atmosphere which would fill the interior of the tumbler. If the inverted tumbler were first placed at the bottom of an empty vessel, and that water were afterwards poured into the latter, the effect would be precisely the same.

The air contained within the upper part of a diving-bell not only debars the ingress of water, but, like the rarified air in the balloon, gives the machine such a buoyancy, that, unless made very substantial, and duly laden at the bottom, or broadest part, it would sink with difficulty, and be apt to turn on its side, so that the air would escape. Under the head of DIVING-*bell* the reader will find an ample detail of the inventions hitherto extant in that branch of adventure.

With regard to the depth to which floating bodies become immersed in fluids, we may consider the following general principles, or propositions, to be sufficient for the purpose of our readers. Bodies whose bases, or bottoms, are angular, like the keels of ships, will be immersed deeper than those whose bases are flat, such as barges: hence sharp-built vessels necessarily (to use the technical term) "draw more water" than those of a more obtuse form: the reason for which is easily demonstrated; *viz.* As every body floating on a fluid will be immersed in proportion to its weight, and will displace a quantity of water equal thereto, it follows, that as a triangle is equal to only half a parallelogram of equal base and altitude, a parallelogram (or flat-bottomed vessel) will, under equal pressure, sink only half the depth of a triangular shaped bottom of equal base and altitude. For the same reason, vessels that have sharp stems make an easier passage through the water than such as are more "bluff," or obtuse, "at the bows:" the more acute the triangle, in that part, the less the resistance; for the triangle displaces only half the quantity of water that would be removed by a parallelogram of equal base and altitude; *ergo*, it would proceed twice as far within a given time as the latter, were not the friction in some degree increased.

It must be obvious, that whether the vessel alone, or the circumstance of her being laden, cause her to weigh more than the quantity of water displaced by her whole bulk, up to the very gunwale, is not material; for in such case she cannot float, but must be depressed by the sum of specific gravity thus produced. This will appear in a very natural and simple manner, if we load a cup with small shot, &c.; for, though partly empty, the cup will sink whenever the whole weight may exceed that of the water displaced. Both the cup and the shot are, however, specifically heavier than their bulk of water, and the former would sink if let in sideways; but then it would only displace a quantity of water corresponding with its own bulk, which would be trivial when compared with that removed by its pressure as a floating body. On the other hand, we find that a ship may be laden with cotton, which is far lighter than water, so as to sink, at least to a level with the water, though not to precipitate to the bottom, unless forced by the adjunction, in whatever form or manner, of such other substances as are heavier than water, by which the levity of the cotton may not only be counterpoised, but exceeded. In India, where the principles of hydrostatics are absolutely unknown, the peasants make rafts of the straw, which they perceive to be lighter than water, and on them load the corn threshed from that straw, perceiving it to be heavier than water. Thus they act upon the best principles merely from observation!

Perhaps, among the most curious circumstances that come within the verge of our subject, nothing can more fully exemplify what has been advanced than the fact, well known, of some vessels sailing better *upon* than *before* the wind. We have no doubt that, if the forms of their bottoms were correctly ascertained, they would be found to present such a surface in the former position, when "keeled a little," as created a more favourable position of the gravity of the vessel, though it must be at least equal, or indeed greater, if much pressed by the wind, than in the latter position.

Before we quit this subject, it is necessary to inform the reader, that, except in cases relating purely to statics, few instances occur in which the various matters appertaining to hydrostatics can be treated in a manner perfectly abstracted from pneumatics, or from hydrodynamics. Under the head of FLUIDS and of HYDRAULICS we have treated of the principles of fluids in motion, in such a way as may give a popular idea of those very intricate subjects; recommending to the student to read the whole contained under those articles with attention, and combining their several actions as derived from one great principle.

HYDRO *sulphuret*, in chemistry, the combination of sulphuretted hydrogen, with

an alkaline or earthy base. The general properties of these substances are, that they are soluble in water, and are chrystallizable; the solution is colourless, while the action of the air is excluded, but when that is admitted, a yellow colour is soon acquired, owing to the oxygen of the atmosphere combining with the hydrogen of a portion of the sulphuretted hydrogen, while the sulphur combines with the remaining portion of it, forming a super-sulphuretted hydrogen, in union with the base. Mr. Murray observes, that "the knowledge which we have acquired of sulphuretted hydrogen, and of its combinations, has thrown light on the composition of the mineral sulphureous waters, and of the changes which they suffer. As sulphur is by itself insoluble in water, and, as frequently no traces of an alkali, by which it might be rendered soluble, could be discovered in them, chemists found it difficult to conjecture by what means its solution was effected. The discovery of sulphuretted hydrogen, and of its solubility in water, solved the difficulty; and the mutual action exerted between it and the oxygen elucidate the changes these waters suffer from exposure to the air."

HYGROMETER, a machine or instrument, to measure the degrees of dryness or moisture of the atmosphere.

There are divers sorts of hygrometers; for whatever body either swells or shrinks, by dryness or moisture, is capable of being formed into an hygrometer. Such are woods of most kinds, particularly ash, deal, poplar, &c. Such also is catgut, the beard of a wild oat, &c.

All bodies that are susceptible of imbibing water have a greater or less disposition to unite themselves with that fluid, by the effect of an attraction similar to chemical affinity. If we plunge into water several of these bodies, such as wood, a sponge, paper, &c., they will appropriate to themselves a quantity of that liquid, which will vary with the bodies respectively; and, as in proportion as they tend towards the point of saturation, their affinity for the water continues to diminish, when those which have most powerfully attracted the water, have arrived at the point, where their attractive force is found solely equal to that of the body, which acted most feebly upon the same liquid, there will be established a species of equilibrium between all those bodies, in such manner, that at this term the imbibing will be stopped. If there be brought into contact two wetted or soaked bodies, whose affinities for water are not in equilibrio; that whose affinity is the weakest, will yield of its fluid to the other, until the equilibrium is established; and it is in this disposition of a body to moisten another body that touches it, that what is called humidity properly consists. Of all bodies, the air is that of which we are most interested to know the different degrees of humidity, and it is also towards the means of procuring this knowledge, that philosophers have principally directed their researches; hence the various kinds of instruments that have been contrived to measure the humidity of the air. A multitude of bodies are known, in which the humidity, in proportion as it augments or diminishes, occasions divers degrees of dilatation or of contraction, according as the body is inclined to one or other of these effects, by reason of its organization, of its texture, or of the disposition of the fibres of which it is the assemblage. For example, water, by introducing itself within cords, makes the fibres twist and become situated obliquely, produces between those fibres such a separation, as causes the cord to thicken or swell, and, by a necessary consequence, to shorten. The twisted threads, of which cloths are fabricated, may be considered as small cords, which experience, in like manner, a contraction by the action of humidity; whence it happens, that cloths, especially when wetted for the first time, contract in the two directions of their intersecting threads; paper, on the contrary, which is only an assemblage of filaments very thin, very short, and disposed irregularly in all directions, lengthens in all the dimensions of its surface, in proportion as the water, by insinuating itself between the intervals of those same filaments, acts by placing them further asunder, proceeding from the middle towards the edges. Different bodies have been employed successively in the construction of hygrometers, chosen from among those in which humidity produces the most sensible motions. Philosophers have sought also to measure the humidity of the air by the augmentation of weight undergone by certain substances, such as a tuft of wool, or portions of salt, by absorbing the water contained in the air. But, besides that these methods were in themselves very imperfect, the bodies employed were subject to alterations which would make them lose their hygrometric quality more or less promptly; they had, therefore, the double inconvenience of be-

ing inaccurate, and not being of long service. To deduce from hygrometry real advantages, it must be put in a state of rivalry with the thermometer, by presenting a series of exact observations, such as may be comparable in the different hygrometers. The celebrated Saussure, to whom we are indebted for a very estimable work on hygrometry, has attained the accomplishment of this object by a process of which we shall attempt to give some idea. The principal piece in this hygrometer is a hair, which Saussure first causes to undergo a preparation, the design of which is to divest it of a kind of oiliness that is natural to it, and that secures it to a certain point, from the action of humidity. This preparation is made at the same time upon a certain number of hairs forming a tuft, the thickness of which need not exceed that of a writing pen, and contained in a fine cloth serving them for a case. The hairs thus enveloped are immersed in a long-necked phial full of water, which holds in solution nearly a hundredth part of its weight of sulphate of soda, making this water boil nearly thirty minutes; the hairs are then passed through two vessels of pure water, while they are boiling; afterwards they are drawn from their wrapper, and separated; then they are suspended to dry in the air; after which there only remains to make choice of those which are the cleanest, softest, most brilliant, and most transparent. It is known that humidity lengthens the hair, and that the process of drying shortens it. To render both these effects more perceptible, Saussure attached one of the two ends of the hair to a fixed point, and the other to the circumference of a moveable cylinder, that carries at one of its extremities a light index or hand. The hair is bound by a counter-weight of about three grains, suspended by a delicate silk, which is rolled in a contrary way about the same cylinder. In proportion as the hair lengthens or shortens, it causes the cylinder to turn in one or the other direction, and by a necessary consequence, the little index turns likewise, the motions of which are measured on the circumference of a graduated circle, about which the index performs its revolution as in common clocks. In this manner a very small variation in the length of the hair becomes perceptible, by the much more considerable motion that it occasions in the extremity of the index; and it will be easily conceived, that equal degrees of expansion, or of contraction in the hair, answer to equal arcs described by the extremity of the index. To give to the scale such a basis as may establish a relation between all the hygrometers that are constructed upon the same principles, Saussure assumes two fixed terms, one of which is the extreme of humidity, and the other that of dryness: he determines the first by placing the hygrometer under a glass receiver, the whole interior surface of which he had completely moistened with water; the air being saturated by this water, acts by its humidity upon the hair to lengthen it. He moistened anew the interior of the receiver, as often as it was necessary; and he knew that the term of extreme humidity was attained, when, by a longer continuance under the receiver, the hair ceased to extend itself. To obtain the contrary limit of extreme dryness, the same philosopher made use of a hot and well-dried receiver, under which he included the hygrometer, with a piece of iron plate, likewise heated and covered with a fixed alkali. This salt, by exercising its absorbent faculty upon the remaining humidity in the surrounding air, causes the hair to contract itself, until it has attained the ultimate limit of its contraction. The scale of the instrument is divided into a hundred degrees. The zero indicates the limit of extreme dryness, and the number one hundred that of extreme humidity. The effects of moisture and of dryness upon the hair, are modified by those of heat, which act upon it, sometimes in the same sense, and sometimes in a contrary one; so that, if it be supposed, for example, that the air is heated about the hygrometer, on one part, this air, whose dissolving faculty with regard to the water will be augmented, will take away from the hair a portion of the water which it had imbibed, thus tending to shorten the hair; while, on the other part, the heat, by penetrating it, will tend, though much more feebly, to lengthen it; and hence the total effect will be found to consist of two partial and contrary effects, the one hygrometric, the other pyrometric. In observations which require a certain precision, it is therefore necessary to consult the thermometer at the same time with the hygrometer; and on this account, the inventor has constructed, from observation, a table of correction, which will put it in the power of philosophers always to ascertain the degree of humidity of the air, from the effect produced by the heat.

De Luc, who devoted his attention to the same object, has followed a different

method. This philosopher employed, for the construction of his hygrometers, a very thin slip of whale-bone, which performs the same office as the hair in the hygrometer of Saussure. He kept this whale-bone bent by means of a spring, the action of which he preferred to that of a weight: he determined the degree of extreme humidity, by immersing the slip of whale-bone entirely under water; and to fix the opposite limit, which is that of extreme dryness, he made use of calcined lime, which he inclosed with the hygrometer under a glass bell. The choice of lime is founded on this, that the calcination having produced a higher degree of dryness, if it be afterward left to cool, so far that it may be placed without inconvenience under the glass bell destined for the experiment, it will be still found, as to sense, in the same state of dryness, since it is very slow in acquiring humidity; and thus all its absorbent faculty will be employed to dry up, by little and little, the air contained under the receiver, and to make the hygrometer itself pass to a state which approaches the nearest possible to extreme dryness. The hygrometer has been long neglected in meteorological observations; it is necessary to associate with it the thermometer and the barometer, to be in a state to unravel the complication of different causes which influence the variations of the atmosphere; and it is only by the aid of a long series of observations, made by these various instruments, together with all the indications which are deduced from the state of the heavens, that we can obtain such data as will enable us to prognosticate, with great probability, the temporary changes, and to arrive at a plausible theory upon this object, so interesting, and so naturally calculated to excite our curiosity.

Mr. Marshall says, that a simple instrument of this sort may be formed by means of "a flaxen line (large well-manufactured whipcord) five feet long; and having a graduated scale fixed to an index, moving on a fulcrum. The length of the index, from the fulcrum to the point, should be ten inches; that of the lever, from the fulcrum to the middle of the eye, to which the cord is fixed, two and a half." He adds, that "the principle on which this hygrometer acts is obvious. The air becoming moist, the cord imbibes its moisture; the line, in consequence, is shortened, and the index rises. On the contrary, the air becoming dry, the cord discharges its moisture,—lengthens,—and the index falls. It may be true," he says, "that no two hygrometers will keep pace with each other sufficiently to satisfy the curious. He will venture to say, however, from seven month's close attention, that two hygrometers, on this simple construction, have coincided sufficiently for the uses of agriculture. It is true," he adds, "they diminished in the degree of action; but as the scale may be readily diminished in extent, and as a fresh line may be so cheaply and so readily supplied, this is not a valid objection." It is remarked, that "this diminution, in the degree of action, depends considerably on the construction; the propriety, or rather delicacy, of which, rests, almost solely, on this point: the weight of the index should be so proportioned to the weight of the lever and cord, that the cord may be kept perfectly straight, without being too much stretched. He made one with a long heavy index; and, in order to gain a more extensive scale, with a short lever; but, even when it was first put up, it could barely act; and, in a few weeks, it flagged, and was not able to raise the index, though the air was uncommonly moist. He therefore made another, with the same length, both of index and lever, but with a lighter index, and a heavier lever, so as to gain the proportion above-mentioned; and it has acted exeeedingly well." He thinks that no farmer, "who wishes to profit by the hygrometer, should have less than two. Three or four would be more advisable. They would then assist, in correcting each other; and, in case of renewal or alteration, there would be no danger of losing the state of the atmosphere; which, if only one is kept, must necessarily be the case. The principle on which this hygrometer is formed, is not, he says, confined to a small cord, and an index of ten inches long: it may be extended to a rope, of any length or thickness, and to an index and scale, of almost any dimensions and extent." But one, or more, on a portable construction, might, he thinks, be found useful. An axe is the form he has thought of; the edge, graduated, will constitute the scale; and the handle will receive the cord: this may be hung up, in the shade, exposed to the action of the air; or, by means of a spike in the end of the handle, it may be placed in the open field. By placing it on fallow ground, it may be actuated by the perspiration of the earth; among vegetables, by vegetable perspiration; by the means of one, or, more probably, by the

means of several placed at varied heights, the different degrees of moisture at different altitudes may be ascertained, &c. In fact, he considers the hygrometer, whether it is a prognostic of the weather or not, as a most valuable oracle to the farmer. See WEATHER.

HYMEN, in anatomy, a membrane sometimes of a circular, sometimes of a semilunar figure, and sometimes of a form different from both.

HYMENÆA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five-parted; petals five, almost equal; style twisted inwards; legume filled with farinaceous pulp. There is only one species, *viz.* H. courbaril, locust-tree. The wild bees are fond of building their nests in this tree, which grows to a considerable size in the West Indies, and is looked upon as excellent timber; but it must be very old before it is cut, otherwise the heart will be but small. It is in great request for wheel-work in the sugar-mills, particularly for cogs to the wheels, being remarkably hard and tough. Professor Jacquin says, that a cubic foot weighs about a hundred pounds, and that it will take a fine polish.

HYMENOPTERA, in natural history, the fifth order of insects according to the Linnæan system. The insects of this order are furnished with four membranaceous wings, and also with a sting, or a process resembling one. The wasp and the bee are insects of this order. It consists of the following genera:

Ammophila	Mutilla
Apis	Scolia
Chalcis	Sirex
Chrysis	Sphex
Cynips	Tenthredo
Formica	Thynnus
Ichneumon	Tiphia
Leucopsis	Vespa.

HYOBANCHE, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx seven-leaved; corolla ringent, without any lower lip; capsule two-celled, many-seeded. There is but one species, *viz.* H. sanguinea, a native of the Cape of Good Hope, and is parasitical at the roots of shrubs.

HYOSCYAMUS, in botany, *henbane*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla funnel-form, obtuse; stamina inclined; capsule two-celled, covered with a lid. There are eight species.

HYOSERIS, in botany, *swine's lettuce* or *succory*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosi. Cichoraceæ, Jussieu. Essential character: calyx almost equal; down hairy and calycled; receptacle naked. There are ten species.

HYPECOUM, in botany, a genus of the Tetrandria Digynia class and order. Natural order of Corydales. Papaveraceæ, Jussieu. Essential character: calyx two-leaved; petals four, the two outer broader, and trifid; fruit a silique. There are three species.

HYPELATE, in botany, a genus of the Polygamia Monoecia class and order. Essential character: calyx five-leaved; corolla five-petalled; stigma bent down, three-cornered; drupe one-seeded. There is but one species, *viz.* H. trifoliata, a native of Jamaica, where it is common in the low lands.

HYPERBOLA, in geometry, the section, G E H, (Plate VII. Miscel. fig. 5.) of a cone, A B C, made by a plane, so that the axis, E F, of the section inclines to the opposite leg of the cone, B C, which in the parabola is parallel to it, and in the ellipsis intersects it. The axis of the hyperbolical section will meet also with the opposite side of the cone, when produced above the vertex, at D.

Definitions. 1. If at the point E (fig. 6.) in any plane, the end of the rule E H be so fixed, that it may be freely carried round, as about a centre; and at the other end of the rule H there is fixed the end of a thread shorter than the rule, and let the other end of the thread be fixed at the point F, in the same plane; but the distance of the points E F must be greater than the excess of the rule above the length of the thread; then let the thread be applied to the side of the rule E H, by the help of a pin G, and be stretched along it; afterwards let the rule be carried round, and in the mean time let the thread kept stretched by the pin be constantly applied to the rule: a certain line will be described by the motion of the pin, which is called the hyperbola. But if the extremity of the same rule, which was

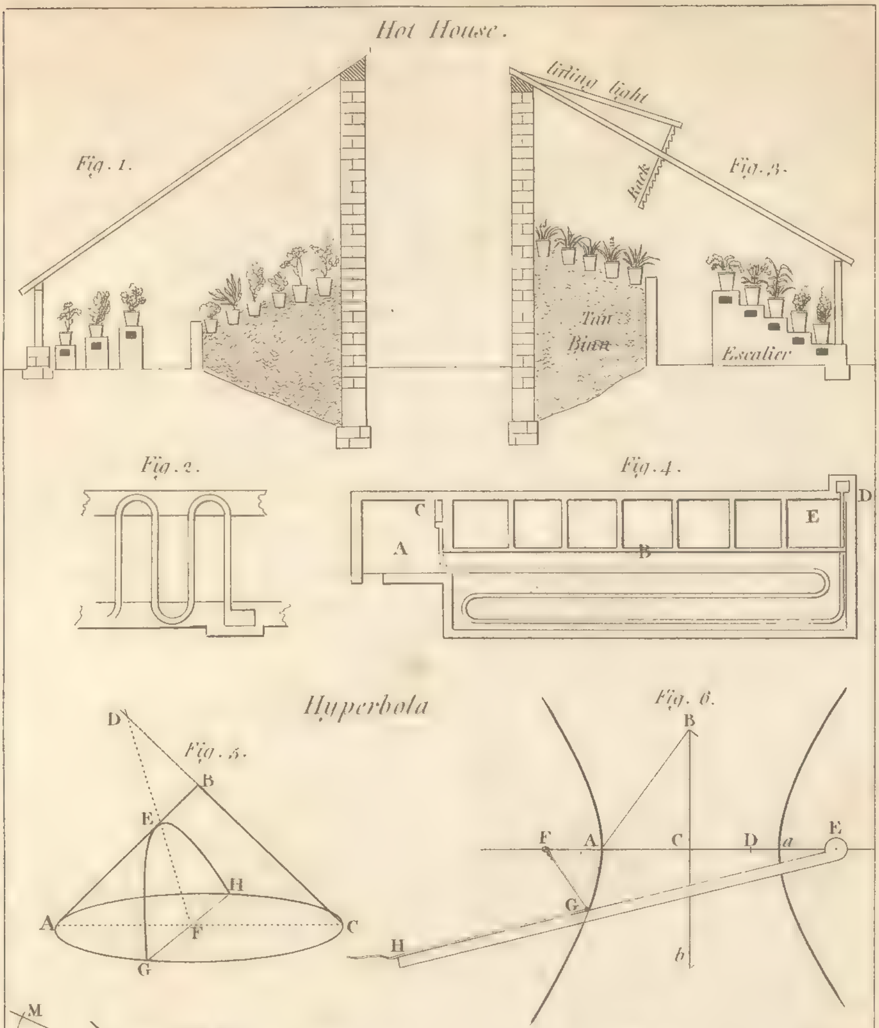
fixed in the point E, is fixed in the point F, and the end of the thread is fixed in the point E, and the same things performed as before, there will be described another line opposite to the former, which is likewise called an hyperbola; and both together are called opposite hyperbolas. These lines may be extended to any greater distance from the points E F, *viz.* if a thread is taken of a length greater than that distance. 2. The points E and F are called the foci. 3. And the point C, which bisects the right line between the two focus's, is called the centre of the hyperbola, or of the opposite hyperbolas. 4. Any right line passing through the centre, and meeting the hyperbolas, is called a transverse diameter; and the points in which it meets them, their vertices: but the right line, which passes through the centre, and bisects any right line terminated by the opposite hyperbolas's, but not passing through the centre, is called a right diameter. 5. The diameter which passes through the foci, is called the transverse axis. 6 If from A or *a*, the extremities of the transverse axis, there is put a right line A D equal to the distance of the centre C from either focus, and with A, as a centre, and the distance A D, there is a circle described, meeting the right line, which is drawn through the centre of the hyperbola at right angles to the transverse axis, in B *b*; the line B *b*, is called the second axis. 7. Two diameters, either of which bisects all the right lines parallel to the other, and which are terminated both ways by the hyperbola, or opposite hyperbolas, are called conjugate diameters. 8. Any right line not passing through the centre, but terminated both ways by the hyperbola, or opposite hyperbolas, and bisected by a diameter, is called an ordinate applied, or simply an ordinate to that diameter: the diameter likewise, which is parallel to that other right line ordinately applied to the other diameter, is said to be ordinately applied to it. 9. The right line which meets the hyperbola in one point only, but produced both ways falls without the opposite hyperbolas, is said to touch it in that point, or is a tangent to it. 10. If through the vertex of the transverse axis a right line is drawn equal and parallel to the second axis, and is bisected by the transverse axis, the right lines drawn through the centre and the extremities of the parallel line are called asymptotes. 11. The right line drawn through the centre of the hyperbola, parallel to the tangent, and equal to the segment of the tangent between the asymptotes, and which is bisected in the centre, is called the second diameter of that which is drawn through the point of contact. 12. A third proportional to two diameters, one of which is the transverse, the other second to it, is called the *latus rectum*, or parameter of that diameter, which is the first of the three proportionals. And, 13. Lastly, fig. 9. If upon two right lines A *a*, B *b*, mutually bisecting each other at right angles, the opposite hyperbolas A G, *a g*, are described; and if upon the same right lines there are described two other opposite hyperbolas, B K, *b k*, of which the transverse axis, B *b*, is the second axis of the two first; and the second axis of the two last, A *a*, is the transverse axis of the two first; these four are called conjugated hyperbolas, and their asymptotes shall be common.

Prop. I. (fig. 6.) The square of the half of the second axis is equal to the rectangle contained by the right lines between the foci and the vertexes of the transverse axis.

Let A *a* be the tranverse axis, C the centre, E and F the foci, and B *b* the second axis, which is evidently bisected in the centre C, from the definition; let A B be joined: then since (by def. 6) A B and C F are equal; the squares of A C and C B together, will be equal to the square of C F, that is, (6. 2.) to the square of A C and the rectangle A F *a* together; wherefore taking away the square of A C which is common, the square of C B will be equal to the rectangle A F *a*.

Prop. II. If from any point G (fig. 7 and 8.) of the hyperbola, a right line G D is drawn at right angles to the transverse axis A *a*, and if from the same point there is drawn the right line G F to the focus nearest to that point; the half of the transverse axis C A will be to the distance of the focus from the centre, *viz.* C F, as the distance of the perpendicular C D, is to the sum of the half of the transverse axis, and the right line drawn to the focus.

Let G E be drawn to the other focus, and on the axis *a* A produced, let there be set off A H equal G F; then with the centre G, and the distance G F, describe a circle cutting the axis *a* A in K and F, and the right line E G in the points L and M: then since E F is double C F, and F K double F D, E K shall be also double C D; and since E L or A *a*, is double C A, and



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L M double G E or A H, E M shall also be double C H; but because of the circle, E L or A a : E F : : E K : E M; and taking their halves, it will be as C A : C F : : C D : C H.

Prop. III. (fig. 7 and 8.) the same things being supposed, if from A the extremity of the transverse axis nearest to the point G, there is set off a right line A H on the axis produced, equal to the distance of the point G from the focus F, nearest to the said extremity; the square of the perpendicular G D shall be equal to the excess of the rectangle E H F, contained under the segments between H (the extremity of the right line A H) and the foci, above the rectangle A D a contained under the segments cut off between the perpendicular and the extremities of the axis.

For since the right line C H is any how cut in A, the squares of C A and C H together will be equal to twice the rectangle A C H, and the square of A H, (7. 2.) *i. e.* because C A, C F, C D, C H are proportionals, to twice the rectangle F C D, and to the square of A H or G F; that is, to twice the rectangle F C D and the squares of F D and D G, that is, to the squares of F C, C D, and D G, (7. 2.) wherefore the two squares of C A and C H are equal to the three squares of F C, C D, and D G; and taking away the squares of C A and C F from both sides, the remaining rectangle E H F, will be equal to the remaining rectangle A D a, and to the square of D G (6. 2.)

Prop. IV. (fig. 7 and 8.) If from any point G of the hyperbola, there is drawn a right line parallel to the second axis B b, meeting the transverse axis A a in D; the square of the transverse axis shall be to the square of the second axis, as the rectangle contained under the segments of the tranverse axis between the parallel and its extremes, to the square of the parallel.

Prop. V. (fig. 8.) If from any point G of the hyperbola there is drawn a right line parallel to the transverse axis A a, meeting the second axis in N; the square of the second axis shall be, to the square of the transverse, as the sum of the squares of the half of the second axis and its segment, between the centre and the right line, to the square of the line itself; that is, $CB^2 : CA^2 :: CB^2 + GD^2 : CA^2 +$ the rectangle A D a; that is, as $CB^2 + CN^2$ is to CD^2 or GN^2.

Prop. VI. (fig. 9.) It is another property of the hyperbola, that the asymptotes, D d, E e, do never absolutely meet with the curve. See Asymptote.

Prop. VII. If through any point F (fig. 9.) of the hyperbola, there is drawn a right line I F L parallel to the second axis, and meeting the asymptotes in I and L; the rectangle contained under the right lines which are intercepted between the asymptotes and the hyperbola, is equal to the square of the half of the second axis, that is, $CB^2 = IFL = IHL$.

Prop. VIII. (fig. 10.) If from any point F of the hyperbola, there is drawn to the transverse diameter, A B, a right line ordinately applied to it F G; and from the extremity of the diameter there is drawn A H perpendicular to it, and equal to the *latus rectum*; the square of the ordinate shall be equal to the rectangle applied to the *latus rectum*, being of the breadth of the abscissa between the ordinate and the vertex, and which exceeds it by a figure like and alike situated to that which is contained under the diameter and the *latus rectum*.

For join B H, and from the point G let there be drawn G M parallel to A H, and meeting B H in M, and through M let there be drawn M N parallel to A B meeting A H in N, and let the rectangles M N H O, B A H P, be completed. Then since the rectangle A G B, is to the square of G F, as A B is to A H, *i. e.* as G B is to G M, *i. e.* as the rectangle A G B is to the rectangle A G M; A G B shall be to the square of G F, as the same A G B to the rectangle A G M: wherefore the square of G F is equal to the rectangle A G M, which is applied to the *latus rectum* A H, having the breadth A G, and exceeds the rectangle H A G O, by the rectangle M N H O, like to B A H P; from which excess the name of hyperbola was given to this curve by Apollonius.

Prob. 1. An easy method to describe the hyperbola, fig. 11. having the transverse diameter, D E, and the foci N n given. From N, at any distance, as N F, strike an arch; and with the same opening of the compasses with one foot in E, the vertex, set off E G equal to N F in the axis continued; then with the distance G D, and one foot in n, the other focus, cross the former arch in F. So F is a point in the hyperbola: and by this method repeated may be found any other point, f, further on, and as many more as you please.

An asymptote being taken for a diameter; divided into equal parts, and through all the divisions, which form so many abscisses

continually increasing equally, ordinates to the curve being drawn parallel to the other asymptote; the abscisses will represent an infinite series of natural numbers, and the corresponding hyperbolic, or asymptotic spaces, will represent the series of logarithms of the same number. Hence different hyperbolas will furnish different series of logarithms; so that to determine any particular series of logarithms, choice must be made of some particular hyperbola. Now the most simple of all hyperbolas is the equilateral one, *i. e.* that whose asymptotes make a right angle between themselves.

Equilateral hyperbola is that wherein the conjugate axes are equal.

Apollonian hyperbola is the common hyperbola, or the hyperbola of the first kind: thus called in contradistinction to the hyperbolas of the higher kinds, or infinite hyperbolas: for the hyperbola of the first kind, or order, has two asymptotes; that of the second order has three; that of the third, four, &c.

HYPERBOLE, in rhetoric, a figure, whereby the truth and reality of things are excessively either enlarged, or diminished. See RHETORIC.

HYPERBOLIC, or *hyperbolical*, something relating either to an hyperbole, or an hyperbola.

HYPERBOLIC *cylindroid*, is a solid figure, whose generation is given by Sir Christopher Wren, in the "Philosophical Transactions." Thus, two opposite hyperbolas being joined by the transverse axis, and through the centre a right line being drawn at right angles to that axis; and about that, as an axis, the hyperbolas being supposed to revolve; by such revolution, a body will be generated, which is called the hyperbolic cylindroid, whose bases, and all sections parallel to them, will be circles. In a subsequent transaction, the same author applies it to the grinding of hyperbolical glasses: affirming, that they must be formed this way or not at all. Hyperbolic leg of a curve, is that which approaches infinitely near to some asymptote. Sir Isaac Newton, reduces all curves, both of the first and higher kinds, into those with hyperbolic legs, and those with parabolic ones.

HYPERBOLIC *line* is used by some authors for what we call the hyperbola itself. In this sense, the plane surface, terminated by the curve line, is called the hyperbola, or hyperbolic space; and the curve line that terminates it the hyperbolic line.

HYPERICUM, in botany, *St. John's wort*, a genus of the Polyadelphia Polyandria class and order. Natural order of Rotaceæ. Hyperica, Jussieu. Essential character: calyx five parted; petals five; filaments many, connected at the base in five bundles. There are fifty-seven species. These are principally shrubs or under shrubs, with cylindrical, ancipital, or quadrangular stems; leaves frequently with pellucid dots; flowers sometimes in cymes, frequently in corymbs, with the peduncles often trichotomous and three flowered.

HYPHYDRA, in botany, a genus of the Monoecia Gynandria class and order. Essential character: male, calyx one-leafed, three parted; corolla none; stamens six, inserted above the germ: female, calyx and corolla none; style triangular, with three stigmas; capsule one celled, three valved; seed single. There is but one species, *viz.* H. fluviatilis, a little plant which grows three or four feet under water; it is a native of Guiana.

HYPNUM, in botany, a genus of the Cryptogamia Musci class and order. Natural order of Musci or Mosses. Generic character: capsule oblong; peristomium double, outer with sixteen broadish teeth, inner membranaceous, equally laciniated; segments broadish with capillary ones interposed. Males germaceous on different plants. Botanists differ greatly as to the number of species, some reckon forty, others fifty, and Dr. Withering enumerates seventy, and to facilitate the investigation of the species he has thrown them into seven divisions.

HYPOCHOERIS, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosi. Cichoraceæ, Jussieu. Essential character: calyx subimbricate; down feathered; receptacle chaffy. There are five species.

HYPOTHECATE, in law, to hypothecate a ship, is to pawn the same for necessaries; and a master may hypothecate either ship or goods for relief, when in distress at sea; for he represents the traders as well as owners; and in whose hands soever a ship or goods hypothecated come, they are liable. But it has been recently held in the Court of King's Bench, that if the master pay for the repairs himself, and do not hypothecate the ship, he has no lien upon the ship for his debt.

HYPOTHENUSE, in geometry, the longest side of a right angled triangle; or it is that side of which subtends the right angle. Euclid, lib. i. proposition 47, demonstrates, that, in every rectilinear right angled triangle, the square of the hypothenuse is equal to the squares of both the other sides. This celebrated problem was discovered by Pythagoras, who is said to have sacrificed a hecatomb to the Muses, in gratitude for the discovery.

HYPOTHESIS, in general, denotes something supposed to be true, or taken for granted, in order to prove or illustrate a point in question. An hypothesis is either probable or improbable, according as it accounts rationally or not for any phenomenon; of the former kind we may reckon the Copernican system and Huygens's hypothesis concerning the ring of Saturn; and the Ptolemaic system may be esteemed an instance of the latter.

HYPOXIS, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Narcissi, Jussieu. Essential character: calyx a two valved glume; corolla, six-parted, permanent, superior; capsule narrower at the base. There are fourteen species.

HYRAX, in natural history, a genus of Mammalia, of the order Glires. Generic character: front teeth in the upper jaw two broad and somewhat distant; in the lower jaw four, broad, flat contiguous and notched; grinders large, four on each side in both jaws; fore-feet, four-toed, hind-feet three-toed; no tail; no clavicles. What distinguishes this genus from the whole class of Glires, besides, is the circumstance of having four teeth instead of two in the lower jaw, and indeed, the teeth in general are differently formed. There are two species.

H. capensis, or the Cape hyrax, is about as large as a rabbit, and abounds in the mountainous districts near the Cape of Good Hope, leaping from rock to rock with extreme agility, feeding by day, and retreating at night to the clefts and holes of the mountains. It has no power of burrowing any recess for itself. Its sound is a reiterated squeak. It subsists entirely on vegetable food, and prepares a bed for its repose and comfort in its favourite recess. It may be easily familiarized, and in a state of domestication is extremely cleanly and alert.

H. syriacus or the bristly hyrax, is to be met with particularly in Ethiopia and Abyssinia, and particularly under the rocks of the Mountains of the Sun. Its full length is about seventeen inches. These animals are called by the natives of these countries Ashkokos. They are gregarious, and, occasionally, seen in companies of several scores basking before the clefts of the rocks in the open sunshine. They are gentle, weak and fearful, but if handled with roughness will bite with great severity. They are supposed to live on grain, fruits, and roots, and when kept in confinement, they will live upon bread and milk. They feed without any voracity, and even the pangs of hunger could not impel them to attack chickens or smaller birds which have been thrown to them in that state, in the way of experiment. Their motion is not firm upon their legs, but rather by stealing along, by a few paces at a time, upon their bellies, in the manner of the bat in approaching its prey. For the Hyrax, see Mammalia, Plate XII. fig. 5.

HYPTIS, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx turbinate; corolla with a very spreading border; lower lip semibifid; anthers hanging down. There are two species.

HYSSOPUS, in botany, *hyssop*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ, Jussieu. Essential character: corolla, lower lip with a small middle crenate segment; stamens straight, distant. There are three species.

HYSTERICS. See MEDICINE.

HYSTRIX, *porcupine*, in natural history, a genus of quadrupeds of the order Glires. Generic character: two fore-teeth in the upper and the under jaw, cut obliquely; eight grinders; body with spines and hair; toes four or five on the fore feet. There are five species. H. cristata, or the common porcupine, is about two feet in length, exclusively of the tail. It is found in Africa and India, and is seen not unfrequently in the warmer climates of Europe, particularly in Italy and Sicily. It is covered on the upper part of its body with variegated spines, or quills, which are long and sharp, and which, when irritated, it erects with particular intenseness, and a rustling and alarming noise, giving the idea of formidable hostility. It was supposed by the ancients to possess the power of darting these with unerring, and sometimes fatal, aim against its adversaries; but it is ascertained to em-

ploy them merely to repel an assailant. Its principal food consists of the bark of trees, roots, and fruit, and is almost universally collected by it in the night. In the day it lies retired, and sleeping in a subterraneous habitation, which it is said to construct with particular ingenuity, dividing it into several apartments. It produces two at a birth, and if taken young is tamed with considerable facility. Its flesh is eaten not only in Africa but in Italy, and is thought extremely luscious, on which account it can be taken by few in any large quantity. See Mammalia, Plate XII., fig. 3.

H. prehensilis, or the Brazilian porcupine. This is about a foot long, and its tail about a foot and half, by which it clings to the branches of trees, and facilitates its object of attack or escape. It is covered with strong, short, and extremely sharp spines, on most of those parts of its body particularly exposed to assault. It is found in the warm climates of America, and particularly in Brazil, where it inhabits the woods, and subsists not only upon fruits and vegetables, like the former species, but also on small birds. Its sounds resemble the grunting of a pig. It secludes itself during the day in the hollows of trees, or under their roots, and by night engages in its excursions and repasts. See Mammalia, Plate XII. fig. 4.

I.

I, or i, the ninth letter, and third vowel of the alphabet, is pronounced by throwing the breath suddenly against the palate, as it comes out of the larynx, with a small hollowing of the tongue, and nearly the same opening of the lips as in pronouncing *a* or *e*. Its sound varies; in some words it is long, as *high*, *mind*, &c.; in others short, as *bid*, *hid*, *sin*, &c.; in others again it is pronounced like *y*, as in *collier*, *onion*, &c.; and in a few it sounds like *ee*, as in *machine*, *magazine*, &c. No English word ends in *i*, *e* being either added to it, or else the *i* turned into *y*.

But besides the vowel, there is the jod consonant; which because of its different pronunciation, has likewise a different form, thus, J, j. In English it has the soft sound of *g*, nor is used but when *g* soft is required before vowels, where *g* is usually hard: thus we say *jack*, *jet*, *join*, &c. instead of *gack*, *get*, *goin*, &c. which would be contrary to the genius of the English language.

I, used as a numeral, signifies no more than one, and stands for so many units as it is repeated times: thus I, one; II, two; III, three, &c. and when put before a higher numeral it substracts itself, as IV, four; IX, nine, &c.: but when set after it, so many are added to the higher numeral as there are I's added: thus VI, is $5+1$, or six; VII, $5+2$, or seven; VIII, $5+3$, or eight. The ancient Romans likewise used IↃ for 500, CIↃ for 1,000, IↃↃ for 5,000, CCIↃↃ for 10,000, IↃↃↃ for 50,000, and CCCIↃↃↃ for 100,000. Farther than this, as Pliny observes, they did not go in their notation; but when necessary, repeated the last number, as CCCIↃↃↃ, CCCIↃↃↃ for 200,000; CCCIↃↃↃ, CCCIↃↃↃ, CCCIↃↃↃ for 300,000; and so on.

JACK, in mechanics, an instrument of common use for raising heavy timber, or very great weights of any kind.

The common kitchen jack is a compound engine, where the weight is the power applied to overcome the friction of the parts, and the weight with which the spit is charged; and a steady and uniform motion is obtained by means of the fly.

JACK, in naval affairs, a sort of flag, or colours, displayed from a staff erected on the outer end of a ship's bowsprit. In the British navy the jack is a small union flag; but in merchant ships the union is bordered with red.

JACK, *smoke*. See SMOKE *jack*.

JACK *in the box*, a large wooden male screw, turning in a female one, which forms the upper part of a strong wooden box, shaped like a frustrum of a pyramid. It is used by means of levers passing through holes in it, as a press in packing, and for other purposes.

JACK *block*, a block occasionally attached

to the top-gallant-tie, and through which the top-gallant top-rope is reeved to sway up or to strike the yard.

JACKALL, in zoology, an animal of the dog kind, with a slender snout. See CANIS.

JACKET, *cork*. See CORK *jacket*.

JACOB'*s staff*, sometimes called a cross-staff, a mathematical instrument to take altitudes at sea, consisting of a brass circle divided into four equal parts by two lines cutting each other in the centre: at each extremity of either line is fixed a sight perpendicularly over the lines, with holes below each, slit for the better discovery of distant objects. The cross is of course mounted on a stand for use.

JACOBUS, an ancient gold coin worth 25*s*. See COIN.

JACQUINIA, in botany, so named in honour of Nic. Jos. de Jacquin, professor of botany at Vienna, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Sapotæ, Jussieu. Essential character: corolla ten-cleft; stamens inserted into the receptacle; berry one-seeded. There are four species, natives of the West Indies and South America.

JACTITATION *of marriage*, in law, is when one of the party boasts, or gives out, that he or she is married to the other, whereby a common reputation of their matrimony may ensue. On this ground the party injured may libel the other in the spiritual court; and unless the defendant undertake, and make out a proof of the actual marriage, he or she is enjoined perpetual silence on that head.

JADE. See NEPHRITE.

JALAP is the root of the convolvulus jalappa. It derives its name from Xalapa, a town of Mexico, in the environs of which it grows plentifully. It is also found among the sands of Vera Cruz. This plant resembles in appearance the convolvulus of our hedges. Its stem is climbing, angular, and covered with a slight down. Its leaves alternately disposed are rather large, sometimes entire and cordiform, sometimes divided into several lobes, more or less distinct. The flower is campaniform, whitish on the outside, and of a dark purple within. Its root, which is the only part in use, is tuberose, large, lengthened out into the form of a French turnip, white on the inside, and full of a milky juice. The weight of the roots is from twelve to twenty pounds. They are cut into slices, in order to dry them. They then acquire a brown colour, and a resinous appearance. Their taste is rather acrid, and excites a nausea. Jalap to the amount of 50,000*l*. sterling is consumed in Europe annually.

IAMBICS, certain songs, or satires, which are supposed to have given birth to the ancient comedy. The word is applied also to a particular kind of Latin verse, of which the simple foot consists of a short and long syllable. Ruddiman makes two kinds of iambic, *viz*. dimeter and trimeter; the former containing four feet, and the latter six.

JANSENISTS, in church history, a sect of the Roman Catholics in France, who follow the opinions of Jansenius, bishop of Ypres, and doctor of divinity of the Universities of Louvain and Douay, in relation to grace and predestination.

In the year 1640, the two universities just mentioned, and particularly Father Molina and Father Leonard Celsus, thought fit to condemn the opinions of the Jesuits on grace and free-will. This having set the controversy on foot, Jansenius opposed to the doctrine of the Jesuits the sentiments of St. Augustine, and wrote a treatise on grace, which he entitled Augustinus. This treatise was attacked by the Jesuits, who accused Jansenius of maintaining dangerous and heretical opinions; and afterwards, in 1642, obtained of Pope Urban VIII. a formal condemnation of the treatise wrote by Jansenius: when the partisans of Jansenius gave out that this bull was spurious, and composed by a person entirely devoted to the Jesuits. After the death of Urban VIII. the affair of Jansenism began to be more warmly controverted, and gave birth to an infinite number of polemical writings concerning grace; and what occasioned some mirth, was the titles which each party gave to their writings: one writer published "The Torch of St. Augustin," another found "Snuffers for St. Augustin's Torch," and Father Vernon formed "A Gag for the Jansenists," &c. In the year 1650, sixty-eight bishops of France subscribed a letter to Pope Innocent X. to obtain an inquiry into, and condemnation of the five following propositions, extracted from Jansenius's Augustinus: 1. Some of God's commandments are impossible to be observed by the righteous, even though they endeavour, with all their power, to accomplish them. 2. In the state of corrupted nature, we are incapable of resisting inward grace. 3. Merit and demerit in a state of corrupted nature, does not depend

on a liberty which excludes necessity, but on a liberty which excludes constraint. 4. The semipelagians admitted the necessity of an inward preventing grace for the performance of each particular act, even for the beginning of faith, but they were heretics in maintaining that this grace was of such a nature, that the will of man was able either to resist or obey it. 5. It is semipelagianism to say, that Jesus Christ died, or shed his blood, for all mankind, in general.

JARGON. See ZIRCON.

JASIONE, in botany, a genus of the Syngenesia Monogamia class and order. Natural order of Campanaceæ. Essential character: calyx, common, ten-leaved; corolla five-petalled, regular; capsule inferior, two-celled. There are four species, natives of the West Indies.

JASMINUM, in botany, English *jasmine-tree*, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Essential character: corolla salver-shaped; berry dicoccous; seeds arillated; antheræ within the tube. There are seventeen species.

JASPER, in mineralogy, a species of the clay genus, divided by Werner into six sub-species, *viz.* the Egyptian, the striped, the porcelain, the common, the agate, and the opal jasper.

The Egyptian jasper exhibits two or more colours in concentric zones or bands, more or less regular, with interspersed spots or dendritic figures. It is brittle, and the specific gravity is about 2.6. It occurs in rolled pieces, which are mostly spherical. Before the blow-pipe it is infusible without addition. It is found in Egypt and the adjoining desarts, and on account of its beautiful colour and great hardness, it is used for similar ornamental and useful purposes as the agate.

The colours of the striped jasper are grey, green, yellow, and red; these are often found together, and arranged in striped and flamed delineations. It occurs in large beds in Saxony, and also in Siberia, where it is of a very beautiful kind. It admits of a high polish, and is used for purposes of ornament chiefly. It derives its name from the striped colour delineations with which it is marked. The porcelain jasper generally exhibits but a single colour, and is sometimes marked with cloudy delineations. It melts before the blow-pipe, and is found to consist of

Silica	60.75
Alumina	27.25
Magnesia	3.00
Oxide of iron	2.50
Potash	3.66
	97.16
Loss	2.84
	100.

It occurs in beds in pseudo-volcanic hills, and is supposed that it is slaty clay, converted into a kind of porcelain by the action of fire. It is found in great plenty in Bohemia.

The common jasper is found generally in veins that occur in primitive rocks in many parts of Europe. It is susceptible of a high polish, and is in considerable request for ornamental purposes. Opal jasper is found in nests, in porphyry, near Tokay, in Hungary, in the neighbourhood of Constantinople, and in some Siberian mountains. It is supposed to be the connecting link between jasper and opal, and is distinguishable by the liveliness of its colours, its superior lustre, and constant conchoidal fracture.

JATROPHA, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, calyx none; corolla one-petalled, funnel-form; stamina ten, alternately longer and shorter: female, calyx none; corolla five-petalled, spreading; styles three, bifid; capsule three-celled; seed one. There are fourteen species, of which we shall give a short account of the J. elastica, elastic gum-tree; it is a native of Guiana, of Quito, and Brazil, particularly in Para, where it is called massaradub. The Indians, by an incision in the bark, extract a viscid white substance, like that which issues from the fig-tree; they receive it into earthen moulds, to make rings, bracelets, girdles, syringes, hats, boots, flambeaux, figures of animals, &c. The Abbé Rochon says that the inhabitants of Madagascar also made flambeaux of it, which burn without wicks, and afford them a very good light when they go out to fish in the night time; that surgery has derived some benefit from it, as it serves to make excellent bandages, and that in a state of solution it is very proper for coating over silk, to render it impervious to air or water. It has the extensibility of leather, with a very considerable elasticity.

Spirit of wine makes no impression on this substance, but it dissolves in ether and linseed oil, or in nut oil digested gently in a sand bath: there are also other fat and oily substances which affect it very sensibly. The Chinese have been long acquainted with the art of dissolving it, and of giving it various colours.

JAUNDICE. See MEDICINE.

JAY, in ornithology, the variegated corvus, with the covering feathers of the wings blue, variegated with black and white. See CORVUS.

IBERIS, in botany, *candy-tuft*, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ, or Cruciformes. Cruciferæ, Jussieu. Essential character: corolla irregular, with the outer petals larger; silicle emarginate, many-seeded. There are fourteen species.

IBEX, in zoology, an animal of the goat kind, with extremely long nodose horns, which bend backwards, and are of a blackish colour, and annulated on the surface. The body is of a dark dusky colour, and is less in proportion to the height than that of the common goat: it has a great resemblance to the deer kind; the legs are also perfectly like those of the deer, straight, elegant, and slender. It is frequent in many parts of Europe, and, notwithstanding its vast horns, runs and leaps with surprising force and agility. See CAPRA.

ICE, water in the solid state. When water is exposed to a diminished temperature, it assumes the solid state, by shooting into crystals which cross each other in angles of 60 degrees. During this process of solidification, the temperature remains constant, being 32 degrees of the scale of Fahrenheit. See CALORIC; also FREEZING.

During congelation most of the gasiform fluids, which may have been contained in the water, are separated in the elastic form, and exhibit bubbles in the ice, unless the congelation may have been gradually effected from the bottom, or one of the sides; in which case the bubbles are driven out, and the ice is much clearer.

Ice is considerably lighter than water, namely, about one-eighth part; and this increase of dimensions is acquired with prodigious force, sufficient to burst the strongest iron vessels, and even pieces of artillery. It does not arise from the extrication of the gases; for the refractive power of ice is less than that of water, as Dr. Hook long ago shewed, and has since been confirmed by Wollaston.

M. Prévost observes, that congelation takes place much more suddenly than the opposite process of liquefaction; and that, of course, the same quantity of heat must be more rapidly extricated in freezing, than it is absorbed in thawing; that the heat thus extricated being disposed to fly off in all directions, and little of it being retained by the neighbouring bodies, more heat is lost than is gained by the alternation: so that where ice has once been formed, its production is in this manner redoubled. This circumstance must occur wherever it freezes, that is, on shore, in latitudes above 35 degrees; and it appears, from 30 degrees to the pole, the land is somewhat colder than the sea, and the more as it is farther distant from it; and nearer the equator the land is warmer than the sea: but the process of congelation cannot, by any means, be the principal cause of the difference, and it is probable that the different capacity of earth and water for heat is materially concerned in it.

Since the atmosphere is very little heated by the passage of the sun's rays through it, it is naturally colder than the earth's surface; and for this reason, the most elevated tracts of land, which are the most prominent, and the most exposed to the effects of the atmosphere, are always colder than situations nearer the level of the sea.

The northern hemisphere is somewhat warmer than the southern, perhaps because of the greater proportion of land that it contains, and also in some measure on account of the greater length of its summer than that of the southern; for although, as it was long ago observed by Simpson, the different distance of the sun compensates precisely for the different velocity of the earth in its orbit, with respect to the whole quantity of heat received on either side of the equinoctial points, yet M. Prévost has shown, that in all probability, the same quantity of heat must produce a greater effect when it is more slowly applied; because the portion lost by radiation from the heated body is greater, as the temperature is higher. Since, therefore, on account of the excentricity of the earth's orbit, the north pole is turned towards the sun seven or eight days longer than the south pole, the northern winters must be milder than the southern; yet the southern summers, though shorter, ought to be somewhat warmer than the northern; but, in fact, they are colder, partly perhaps from the much greater proportion of sea, which, in

some degree, equalizes the temperature, and partly for other reasons. The comparative intensity of the southern summer and winter is not exactly known; but in the island of New Georgia, the summer is said to be extremely cold.

The northern ice extends about 9° from the pole; the southern 18° or 20°; in some parts even 30°; and floating ice has occasionally been found in both hemispheres as far as 40° from the poles, and sometimes, as it has been said, even in latitude 41° or 42°. Between 54° and 60° south latitude, the snow lies on the ground, at the sea-side, throughout the summer. The line of perpetual congelation is three miles above the surface at the equator, where the mean heat is 84°; at Teneriffe, in latitude 28° two miles; in the latitude of London, a little more than a mile; and in latitude 80° north, only 1,200 feet. At the pole, according to the analogy deduced by Mr. Kirwan, from a comparison of various observations, the mean temperature should be 31°. In London, the mean temperature is 50°; at Rome and at Montpelier, a little more than 60°; in the island of Madeira, 70°; and in Jamaica, 80°.

Ice *house*, a building contrived to preserve ice for the use of a family in the summer season. Ice houses are more generally used in warm countries, than with us, particularly in Italy, where the meanest person who rents a house, has his vault or cellar for ice. However, as ice is much more used in England than it was formerly, it may not be amiss to give some directions for the choice of their situation, for the manner of building them, and for the management of the ice.

As to the situation, it ought to be placed upon a dry spot of ground, because wherever there is moisture, the ice will melt; therefore, in all strong lands which retain the wet, too much pains cannot be taken to make drains all round them. The place should also be elevated, and as much exposed to the sun and air as possible.

As to the figure of the building, that may be according to the fancy of the owner; but a circular form is most proper for the well in which the ice is to be preserved; which should be of a size and depth proportionable to the quantity to be kept; for it is proper to have it large enough to contain ice for two years consumption, so that if a mild winter should happen, in which little or no ice is to be had, there may be a stock to supply the want. At the bottom of the well there should be a space of about two feet deep left to receive any moisture that may drain from the ice; over this space should be placed a strong wooden grate, and from thence a small drain should be laid under ground, to carry off the wet. The sides of the well should be built with brick, at least two bricks thick; for the thicker it is, the less danger there will be of the well being affected by any external cause. When the well is brought up within three feet of the surface, there should be another outer arch or wall begun, which should be carried up to the height of the top of the intended arch of the well; and if there be a second arch turned over this wall, it will add to the goodness of the house: the roof must be high enough above the inner arch to admit of a door-way to get out the ice. If the building is to be covered with slates or tiles, reeds should be laid considerably thick under them, to keep out the sun and external air; and if these reeds are laid the thickness of six or eight inches, and plastered over with lime and hair, there will be no danger of the heat getting through them. The external wall may be built in what form the proprietor pleases; and as these ice-houses are placed in gardens, they are sometimes so contrived as to have an handsome alcove seat in front, with a small door behind it, through which a person might enter to take out the ice; and a large door on the other side, fronting the north, with a porch wide enough for a small cart to back in, in order to shoot down the ice near the mouth of the well, which need not be more than two feet in diameter, and a stone so contrived as to shut it up in the exactest manner: all the vacant space above and between this and the large door should be filled up with straw. The building thus finished should have time to dry before the ice is put into it.

It is to be observed, that upon the wooden grate, at the bottom of the well, there should be laid some small faggots, and if upon these a layer of reeds is placed smooth for the ice to lie upon, it will be better than straw, which is commonly used. As to the choice of the ice, the thinner it is, the easier it may be broken to powder; for the smaller it is broken, the better it will unite when put into the well. In putting it in, care must be taken to ram it as close as possible; and also to allow a vacancy of about two inches, all round, next the side of the well, to give passage to any moisture

occasioned by the melting of some of the ice. When the ice is put into the well, if a little saltpetre be mixed with it at every ten inches or a foot in thickness, it will cause it to unite more closely into a solid mass.

ICH DIEN, the motto of the Prince of Wales's arms, signifying, in the High Dutch, "I serve." It was first used by Edward the Black Prince, to shew his subjection to his father King Edward III.

ICHNEUMON, in natural history, a genus of insects of the Hymenoptera order: mouth with a straight horny membranaceous bifid jaw, the tip rounded and ciliate; mandibles curved sharp; lip cylindrical, membranaceous at the tip and emarginate; feelers four, unequal, filiform, seated in the middle of the lip; antennæ setaceous, of more than thirty articulations; sting exerted, inclosed in cylindrical sheath, composed of two valves, and not very pungent. There are more than five hundred species enumerated by different authors. These are separated into families. A. scutel, white or yellow; antennæ annulate with white. B. scutel, white or yellow; antennæ entirely black. C. scutel, the colour of the thorax; antennæ annulate. D. scutel, the colour of the thorax; antennæ black. E. antennæ yellow. F. minute; antennæ filiform; abdomen sessile, ovate.

The whole of this singular genus have been denominated parasitical, on account of the very extraordinary manner in which they provide for the future support of their offspring. The fly feeds on the honey of flowers, and when about to lay her eggs, perforates the body of some other insect, or its larva, with its sting or instrument at the end of the abdomen, and there deposits them. These eggs in a few days hatch; and the young larva, which resemble minute white maggots nourish themselves with the juices of their foster parent, which however continues to move about and feed till near the time of its change to a chrysalis, when the larva of the ichneumon creep out by perforating the skin in various places, and each spinning itself up in a small oval silken case, changes into a chrysalis, and after a certain period they emerge in the state of complete ichneumons.

I. glomeratus, may be given as an example of this process. The caterpillar of the common white or cabbage butterfly, which, in the autumnal season, may be observed to creep up some wall, &c. in order to undergo its own change into a chrysalis; but in the space of a day or two, a numerous tribe of small maggots will be seen to emerge from it, and immediately proceed to envelope themselves in distinct yellow, silken cases, the whole forming a group round the caterpillar. These are the ichneumons glomeratus: they are black, with yellow legs, and they usually make their appearance in about three weeks from the time of their spinning themselves up. Some of the ichneumon genus pierce the skins of newly-changed chrysalises of butterflies and moths, in which their larva remain during their own incomplete state. Others are so minute, that the female pierces even the eggs of moths and butterflies, and deposits her own in each. I. seductor, has a yellow scutel; tip and petiole of the abdomen and crenate band on the fore-part yellow; legs mostly yellow. This insect is found chiefly in Pavia; it forms a nest of cemented clay, in chimneys and windows, divided into cylindrical cells, in each of which is contained a cylindrical, brown, lucid follicle, and in this the larva, with frequently the carcase of a spider, in which the insect had deposited her eggs.

ICHNOGRAPHY, in perspective, the view of any thing cut off by a plane parallel to the horizon, just at the base of it.

Ichnography, in architecture, a description or draught of the platform or ground-work of a house, or other building. Or it is the geometrical plan or platform of an edifice or house, or the ground-work of an house or building, delineated upon paper, describing the form of the several apartments, rooms, windows, chimnies, &c.

Ichnography, in fortification, denotes the plan or representation of the length and breadth of a fortress, the distinct parts of which are marked out, either on the ground itself, or on paper.

ICHTHYOCOLLA. See Isinglass.

ICHTHYOLOGY, is that part of natural history that treats of fishes. And fishes are animals having a heart with one auricle and one ventricle, with cold red blood, which inhabit water, and breathe by means of gills. Most of the species are likewise distinguished by fins and scales. Different naturalists have given different systems, we shall briefly notice some of the principal, because we find them perpetually referred to in works of importance. Aldrovandus, about two hundred years ago, distributed the fishes according to the nature of their residence. His first book treats of those that frequent rocks; the second is devoted to those found near the shores, called litto-

ral; the third, pelagian, &c. Willoughby formed his system from his observation on the anatomy and physiology of fishes; he was followed by Ray, who fixed a series of genera. Artedi, the friend and countryman of Linnæus, has the merit of having first traced the outlines of that classification of fishes which is now almost generally adopted. For, independently of the cetaceous tribes, which are now generally classed with the mammalia, his method consisted of four orders, *viz.* 1. The malacoterygian, or those which have soft fins, or fins with bony rays, but without spines. 2. The acanthopterian, those with spiny fins. 3. The branchiostegeous, corresponding to the amphibia nantes of Linnæus. 4. The chondropterygian, or those which have not true bones, but only cartilages, and the rays of whose fins hardly differ from a membrane. At first Linnæus adopted this method entirely, but he afterwards improved upon it; and now, according to his system, the orders have been instituted from the situation, presence, or absence of the ventral fins.

1. Such as are entirely destitute of these fins, are termed pisces apodes, apodal or footless fishes. 2. The jugulares, or jugular, are those which have ventral fins, placed more forward than the pectoral fins, or under the throat. 3. The thoracici, or thoracic, include those whose ventral fins are placed immediately under the pectoral fins, or on the breast. 4. The abdominales, or abdominal, comprise those whose ventral fins are situated behind the pectoral fins, or on the abdomen. 5. There still remains a particular tribe, denominated cartilaginei, which, as their name imports, have a cartilaginous instead of a bony skeleton. This tribe was by Linnæus separated from the rest, on the mistaken idea, that the individuals which compose it were furnished, both with lungs and gills, and should be ranked in the class of amphibious animals.

The genera which pertain to the preceding orders are determined by the number of rays in the branchiostegous membrane, the condition of the teeth, the figure of the body, and of other remarkable parts. The characters of the species are taken chiefly from the number of rays in the fins, which differs in the different species. But, as the precise enumeration of these rays is sometimes a matter of difficulty, and, as they are likewise subject to variation, it is necessary to have recourse to other marks, and to adopt, as subsidiary characters, the form and situation of particular fins, the proportion of the head to the body, the condition of the lateral line, the number of the vertebræ and ribs, &c.

Mr. Pennant describes fishes under the three great divisions of cetaceous, cartilaginous, and bony. The latter which is by far the most numerous, he subdivides into four sections entitled agreeably to the Linnæan orders apodal, thoracic, jugular, and abdominal.

The shape of the body of fishes is subject to considerable varieties. It is said to be compressed, when the diameter, from side to side, is less than from back to belly; and depressed, on the contrary, when the diameter, from side to side, is greater than from back to belly. It is cylindrical, when it is circular in the greater part of its length; ensiform, or sword-shaped, when the back and belly terminate in a sharp edge, or when the body gradually tapers from the head to the tail; cultrated, or knife-shaped, when the back is somewhat flat, and the angle below acute; carinated, or keel-shaped, when the back is rounded, and the under part of the belly acute through its length; oblong, when the longitudinal diameter is much longer than the transverse; oval, when the longitudinal diameter not only exceeds the transverse, but the base is circular, and the apex more acute; orbicular, when the longitudinal and transverse diameters are nearly equal; lamellated, or spear-shaped, when oblong, and attenuated at both extremities; cuneiform, or wedge-shaped, when the body gradually flattens towards the tail; conical, when it is cylindrical, and grows gradually more slender towards the tail; ventricose, when the belly is very prominent; gibbous, when the back presents one or more protuberances; annulated, when the body is surrounded by rings, or elevated lines; articulated, when it is covered with connected and bony plates; trigon, tetragon, pentagon, and hexagon, when the sides are plain, with three, four, or six longitudinal angles; if the number of these angles exceed six, it is termed a polygon.

The surface of the body of fishes is termed naked when it is destitute of scales; scaly, when provided with them; smooth, when the scales are without angles, furrows, roughness, or inequalities; lubricous, or slippery, when invested with a mucous or slimy humour; tuberculated, or rough, when covered with prominent warts or tubercles; papillous, when covered with fleshy points; spinous, when the asperities

are elongated, and pointed at their extremities; loricated, or mailed, when the body is inclosed in a hard, callous, or bony integument, or in scales so closely united as to seem but one; fasciated, or banded, when marked with transverse zones, from the back to the belly; striped, when marked with very narrow, scattered, and coloured streaks; vittated, when marked with longitudinal zones along the side, from the head to the tail; reticulated, or chequered, when marked with lines forming the appearance of net-work; pointed, or dotted, when marked with points, either longitudinally disposed, or without order; and variegated, when of different colours.

The head is always placed at the anterior part of the body, and reaches from the extremity of the nose to the gills. The head contains the mouth, nose, jaws, lips, teeth, tongue, palate, nostrils, eyes, branchial opercules, the branchiostegous membrane, the aperture of the gills, and the nape. The branchial opercules are scaly, or bony processes, situated on both sides of the head, behind the eyes, closing the aperture of the gills, and sustaining the branchial membrane. The branchial, or branchiostegous membrane, is a true fin, formed of cartilaginous crooked bones, joined by a thin membrane, lurking under the opercula, to which it adheres, and is capable of being folded, or expanded, as necessity requires.

The trunk is that part of the body which extends from the nape and branchial aperture to the extremity of the tail. It comprehends the gills, throat, thorax, back, sides, abdomen, lateral line, anus, tail, and scales. The gills, or branchiæ, consist, for the most part, of four crooked, parallel, unequal bones, furnished on the outer, or convex part, with small soft appendages, like the beards of a feather, and generally of a red colour.

The fins consist of several rays connected by a tender film, or membrane; and they are raised, expanded, or moved, in various directions, by means of appropriate muscles. The rays of the fins are either jointed and flexible small bones, whose extremity is often divided into two parts, or hard and prickly, without division at the extremity. In some cases, those on the back of the fish are furnished with membranaceous appendages, simple, or palmated, and adhering to the apex, or sides. The fins, according to their position, are denominated dorsal, pectoral, ventral, anal, or caudal.

The skeleton of a fish is the assemblage of bones which constitutes the frame-work of its body. The number of these bones is not uniform in each individual, but varies according to age and species. They may be conveniently divided into those of the head, thorax, abdomen, and fins.

The muscles are an assemblage of small bundles of fleshy fibres, partly red, and partly whitish, enveloped in a common membrane. The first of these is called the fleshy portion of the muscle; the second the tendon. Each muscle thus composed, is susceptible of contraction and dilatation. The former is accompanied by a visible swelling, hardening, wrinkling, and shortening of the muscle, and the latter by its elongation, expansion, and recovery of its former softness and flexibility. Its force, in general, depends on the quantity of fibrous matter which enters into its composition, and its moving power on the length and size of the fibres.

The brain of fishes is a very small organ relative to the size of the head. It is divided into three equal lobes, of which the two anterior are contiguous; the third being placed behind, and forming the cerebellum. These three lobes are surrounded by a frothy matter, resembling saliva. In this region the optic and olfactory nerves are easily discovered.

The swimming, or air bladder, or sound, is an oblong white, membranous bag, sometimes cylindrical, sometimes elliptical, and sometimes divided into two or three lobes, of different lengths. It is usually situated between the vertebræ and the stomach, and included within the peritonæum. In some fishes it communicates with the stomach, and in others, with the œsophagus. The flat fishes are unprovided with this organ.

The intestines, which in man are placed transversely, have a longitudinal position in fishes, and are all connected with the substance of the liver. They are in general very short, making only three turns, the last of which terminates in a common outlet or vent. The appendices, or secondary intestines, are very numerous, composing a groupe of worm-like processes, all ultimately terminating in two large canals, opening into the first intestine, into which they discharge their peculiar fluid. We shall, under the word Pisces, give an account of the several functions peculiar to this class of animals.

ICHTHYOPHTHALMITE, in mineralogy, a stone found in Sudermania, of a

yellowish colour; it occurs massive, and crystallized. Specific gravity 2.5 nearly. Before the blow-pipe it froths, and melts into an opaque head. It is supposed to consist of

Silica	52.0
Lime	24.5
Potash	8.1
Water	15.0
	99.6
Loss	.4
	100

ICONOCLASTS, in church history, an appellation given to those persons who, in the eighth century, opposed image-worship, and is still given by the Church of Rome to all Christians who reject the use of images in religious matters.

ICOSAHEDRON, in geometry, a regular solid, consisting of twenty triangular pyramids, whose vertexes meet in the centre of a sphere, supposed to circumscribe it; and, therefore, have their height and bases equal; wherefore the solidity of one of those pyramids multiplied by twenty, the number of bases, gives the solid content of the icosahedron. See Body.

ICOSANDRIA, in botany, the name of the twelfth class in the Linnæan system, consisting of plants with hermaphrodite flowers, furnished with twenty or more stamina, that are inserted into the inner side of the calyx, or petals, or both. By this last circumstance, and not by the number of stamina, is this class distinguished from the class polyandria, in which the number of stamina is frequently the same with that of the plants of the class icosandria, but they are inserted, not into the calyx or petals, but into the receptacle of the flower. The icosandria furnishes the pulpy fruits that are most esteemed, such as apples, plumbs, peaches, cherries, &c. whereas the polyandria are mostly poisonous, as the aconite, columbine, larkspur, hellebore, and others. The species of the icosandria have a hollow flower cup composed of one leaf to the inner side of which the petals are fastened by their claws. In this class there are five orders, founded upon the number of the styles or female organs. The myrtle, almond, and plumb have a single female organ; the wild service, two; the service and sesuvium, three; medlar and apple, &c. five; rose, raspberry, strawberry, &c. an indefinite number.

IDENTITY, denotes that by which a thing is itself, and not any thing else; in which sense, identity differs from similitude as well as diversity. The idea of identity we owe to that power which the mind has of comparing the very being and existence of things, whereby considering any thing as existing at any certain time and place, and comparing it with itself as existing at any other time and place, we accordingly pronounce it the same, or different. Thus, when we see a man at any time and place, and compare him with himself when we see him again at any other time or place, we pronounce him to be the same we saw before.

To understand identity aright, we ought to consider the essence and existence, and the ideas these words stand for; it being one thing to be the same substance; another the same man; and a third, the same person. For, suppose an atom existing at a determined time and place, it is the same with itself, and will continue so to be at any other instant as long as its existence continues; and the same may be said of two or any number of atoms, whilst they continue together; the mass will be the same; but if one atom be taken away, it is not the same mass. In animated beings it is otherwise, for the identity does not depend on the cohesion of its constituent particles, any how united in one mass; but on such a disposition and organization of parts, as is fit to receive and distribute life and nourishment to the whole frame. Man, therefore, who hath such an organization of parts partaking of one common life, continues to be the same man, though that life be communicated to new succeeding particles of matter vitally united to the same organized body; and in this consists the identity of man, considered as an animal only. But personal identity, or the sameness of an intelligent being, consists in a continued consciousness of its being a thinking being, endowed with reason and reflection, capable of pain or pleasure, happiness or misery, that considers itself the same thing in different times and places. By this consciousness every one is to himself, what he calls *self*, without considering, whether that *self* be continued in the same or divers substances; and so far as this consciousness extends backward to any past action, or thought, so far extends the identity of that person, and makes it the object of reward and punishment. Hence it follows, that if the consciousness went with the hand, or

any other limb, when severed from the body, it would be the same self that was just before concerned for the whole. And if it were possible for the same man to have a distinct incommunicable consciousness at different times, he would, without doubt, at different times make different persons; which we see is the sense of mankind as to madmen, for human laws do not punish the madman for the sober man's actions, nor the sober man for what the madman did, thereby considering them as two persons.

IDEAOLOGY. The philosophy of the human mind. We are conscious of our own existence; and in this consciousness we perceive a certain variety or successive change, which we distinguish by the name of thought. It seems as if it would be a vain attempt to investigate by what physical operations the proceedings of the mind may be caused, supported, or governed. The primary objects of thought are derived from our sensations or perceptions. We can form no conception of any subject of thought which shall not be referable to the senses. During the actual time of sensation we suppose ourselves to be operated upon, by some beings or objects which constitute no part of ourselves; and we do not hesitate to infer from those sensations, that an external universe does actually subsist. Berkeley, Hume, and others, have made this a subject of question; and it must be confessed, that we have no absolute proof respecting it. From the certainty, however, that we ourselves do not cause the changes which produce sensation in us, we are irresistibly impelled to an affirmative decision of this question; which after all seems neither important nor useful, more especially when we consider that the same uncertainty pervades all our researches whenever we refine so far as to treat of subjects which are not referable to cause and effect.

In many instances, the sensations we experience afford some resemblance of the objects which cause them, as in the figures of bodies; but in others, it is probable that no such resemblance exists, as in colours, sounds, &c. A distinction has therefore very properly been made, between that which is perceived, and the cause of the perception; and, moreover, as we find that effects, similar to our antecedent perceptions, may and do take place, though the organs of sense are not then acted upon, we make a further distinction between these last, and the perceptions themselves. We call them ideas. They not only resemble the perceptions, as individually considered, but likewise make their appearance in the same arrangement or order of recurrence. We think we perform a positive act, in many instances, in bringing them forward, which we call an act of the memory, or recollection; and their concomitant appearance, or the succession of ideas by recollection, in the similarity or the order of the sensations, has been called the association of ideas. The same term is likewise applied, when we speak of the recurrence, in idea, of an entire contemporaneous sensation, in consequence of part of it being brought forward in the memory.

Much discussion has taken place among philosophers, respecting the origin and nature of our ideas; in which it must be confessed that a mis-application of terms, a confusion of intellectual research, with an admixture of theological notions, and several other causes, have united to render a plain subject considerably obscure, even in the hands of men of much talent and acuteness. In particular, it has been a subject of controversy, whether man possesses innate ideas. If an idea be the recollected picture of a sensation, we must surely date the possession of ideas from the earliest period of the existence of an animal; and it seems absurd to deny to the embryo, before birth, a consciousness of the voluntary power it exerts in muscular motion, or a power of feeling, and perhaps of being affected by sounds:—but without indulging any wildness of conjecture, are we not compelled,—when we see an animal in the first hour after its birth, seek the breast by the act of smelling, follow a visible object with its eyes, and alter the adjustment of their axis according to the distance of that object; when the same infant being set upon its feet, immediately and correctly makes the motion of jumping,—are we not compelled to admit, as incomparably the greater probability, that these powers have subsisted, though not exercised, in the fœtal state, rather than that they should have been created at the instant of its birth? This then is our situation with regard to innate ideas, and it would be a contradiction in terms to speak of innate notions or principles. Those deductions of fitness to an end or purpose, which constitute principle, certainly cannot be made till after the requisite propositions have been presented or

have occurred to the mind. Previously to this, the conscious being may be said to possess the capacity to perceive and to deduce relations; and it seems of very little consequence whether we call this capacity innate or not.

We are so constituted that most of our sensations give us either pleasure or pain; and whenever these are vivid, we are put into a situation of mind respecting them called desire; namely, for the continuance or return of the pleasurable sensations, and for the cessation, or absence, of those that are painful. These desires, in their various modifications and combinations, are distinguished by the general name of the passions. Whenever they are strong and urgent, they engage the mind so fully, that the ordinary association of ideas, and the regular processes of reason become obscured, interrupted,or suspended. A continuance of this state, as when the passions are exalted by disease, is called insanity; and in all states of passion man is more or less insane.

None of our sensations are simple, and consequently none of our ideas can be so. All sensations consist of parts, representing parts of the objects perceived, whether contemporaneously or in succession; and we are also capable of receiving two or more sensations at the same time. Whether the difference between one sensation and another may arise merely from the relations of their own parts with respect to each other, or from any other causes, is not of importance to be discussed in this place; but it is certain that we are greatly interested in observing these relations. Thus we take notice, that one thing is greater or less than another; that in figure, position, duration, and other affections, they are not the same; and that certain changes in inanimate, as well as in conscious beings, are without exception followed by other changes, from which we are led to expect and to foretel events. This last class of observations establishes the doctrine of causes and effects; and a large part of our lives is employed in determining the order of these successions.

Among numerous other inaccuracies which tend to mislead in the investigation of ideaology, a principal one is, that the term idea has been confounded with that of notion. Notions always grow out of the relations of ideas, and they always imply comparison. When the notion or thing asserted, agrees with the ideas or events, (which are ideas considered in succession) it constitutes truth; if otherwise, it is falsehood.

Our sensations in every case, without exception, afford no more than a partial indication of the nature of the objects which cause them. We cannot see the whole of an animal, but only one side, and that very imperfectly; so that the ordinary visible perception of a horse would be the same, whether its hair were long or short, its eyes imperfect or the contrary, &c. and the recollection, or idea, of that individual horse would be still more imperfect, by the omission of particular variations or spots of colour, or other subordinate objects; which, though they may have existed in the sensation, have not remained in the memory. Thus it is, from the nature of things, that some part of the sensations will be abstracted, or left out in the idea: and if in reasoning upon that subject, namely, the horse, a comparison were to be instituted between that animal and a cow,the attributes they have in common would, in some cases, be alone attended to, and in others form the chief object of consideration. In this manner, arbitrarily, or rather from the necessity of the case, we constantly direct our inquiries to abstract ideas, (which are more or less defective, when generally considered) instead of attending to the individuals as we must always do in the sensations; that is to say, when we observe and make experiments. And from these obvious truths we may see how it is that we acquire notions of genera, species, and individuals; how the first elements of language are formed by abstraction; how difficult it is to reason from sensations or experiments, by the use of ideas, which are their, necessarily imperfect, representatives; and how easy it is for us to mislead ourselves, and others, by paralogism, in the use of general propositions, if we do not constantly adhere to the same degrees of abstraction, or if we do not, in all practical applications, again introduce the abstracted parts, which, though we may have rejected them (like numbers in algebra) for the facility of our mental process, must invariably be resumed whenever the theatre of nature or society is to be again entered.

These are the principal outlines of the science which treats of ideas, or the materials of our knowledge, and the conduct of mind, in the disposition and treatment of them. Most writers have treated this sub-

ject either loosely and without order, or by running into divisions upon differences, not of primary importance in the nature of things, have confused the various parts into which it most extensively branches. Hence it is that we hear of ideas of sensation and reflexion; complex ideas of modes, substances, and relations; ideas distinct, confused, real, fantastical, adequate, inadequate, true, and false. See LANGUAGE, also UNDERSTANDING.

IDIOM, among grammarians, properly signifies the peculiar genius of each language, but is often used in a synonimous sense with dialect.

IDIOSYNCRASY, among physicians, denotes a peculiar temperament of body, whereby it is rendered more liable to certain disorders, than persons of a different constitution usually are.

IDIOTS, in law. An idiot is a fool or madman from his nativity, and one who never has any lucid intervals. The king has the protection of him and his estate, during his life, without rendering any account; because it cannot be presumed that he will ever be capable of taking care of himself or his affairs. By the old common-law, there is a writ *de ideota inquirendo*, directed to the sheriff, to inquire by a jury, whether the party be an idiot or not; and if they find him a perfect idiot, the profits of his lands, and the custody of his person, belong to the king, according to the statute 17 Edward II. c. 9, by which it is enacted, that the king shall have the custody of the lands of natural fools, taking the profits of them without waste or destruction, and shall find them necessaries, of whose fee soever the land shall be holden. And, after the death of such idiots, he shall render it to the right heir, so that such idiots shall not aliene, nor their heirs be disinherited. But it seldom happens, that a jury finds a man an idiot from his nativity; but only *non compos mentis*, from some particular time; which has an operation very different in point of law: for, in this case, he comes under the denomination of a lunatic; in which respect the king shall not have the profits of his lands, but is accountable for the same to the lunatic when he comes to his right mind, or otherwise to his executors or administrators. The king, as *parens patriæ*, has the protection of all his subjects; and in a more peculiar manner he is to take care of all those, who by reason of their imbecility, and want of understanding, are incapable of taking care of themselves. But though a lunatic is by commission to be under the care of the public, and such committee is to be appointed for him by the Lord Chancellor, whose acts are subject to the correction and controul of the Court of Chancery; yet such an one, whether so appointed, or whether he of his own head take upon him the care and management of the estate of a lunatic, is but in nature of a bailiff or trustee for him, and accountable to him, his executors, or administrators. And as the committees of a lunatic have no interest, but an estate during pleasure, it has been ruled, that they cannot make leases, nor any ways incumber the lunatic's estate, without a special order from the Court of Chancery, where the profits are not sufficient to maintain the lunatic. In case of a lunatic's recovery, he must petition the Chancellor to supersede the commission; upon the hearing of which the lunatic must attend in person, that he may be inspected by the Chancellor. It is also usual for the physician to attend, and to make an affidavit that the lunatic is perfectly recovered.

An idiot, or person *non compos*, may inherit, because the law in compassion to their natural infirmities, presumes them capable of property. An idiot, or person of non sane memory, may purchase, because it is intended for their benefit; and if after recovery of their memory they agree thereto, they cannot avoid it; but if they die during their lunacy, their heirs may avoid it; for they shall not be subject to the contracts of persons who wanted capacity to contract: so, if after their memory recovered, the lunatic, or person *non compos*, die without agreement to the purchase, their heirs may avoid it. If an idiot or lunatic marry, and die, his wife shall be endowed; for this works no forfeiture, and the king has only custody of the inheritance in one case, and the power of providing for him and his family in the other; but in both cases the freehold and inheritance is in the idiot or lunatic; and therefore if lands descend to an idiot or lunatic after marriage, and the king, on office found, takes those lands into his custody, or grants them over to another as committee in the usual manner; yet the husband shall be tenant by the courtesey, or the wife endowed, since their title does not begin to any purpose till the death of the husband or wife, when the king's title is at an end.

It is a general rule, that idiots and lunatics, being by reason of their natural disabilities incapable of judging between good and evil, are punishable by no criminal prosecution whatsoever. And therefore a person who loses his memory by sickness, infirmity, or accident, and kills himself, is no *felo de se*. And as a person *non compos* cannot be a *felo de se* by killing himself, so neither can he be guilty of homicide in killing another, nor of petit treason. If one committed for a capital offence become *non compos* before conviction, he shall not be arraigned; and if after conviction, he shall not be executed.

There is a distinction between acts done by idiots and lunatics *in pais*, and in a court of record; that as to those solemnly acknowledged in a court of record, as fines and recoveries, and the uses declared on them, they are good, and can neither be avoided by themselves, nor their representatives, for it is to be presumed, that had they been under these disabilities, the judges would not have admitted them to make those acknowledgements. Therefore, if a person *non compos* acknowledge a fine, it shall stand against him and his heirs. And to acts done by them *in pais*, they are distinguished into void and voidable, though as to themselves they are regularly unavoidable, because no man is allowed to disable himself, for the insecurity that may arise in contracts from counterfeited madness and folly; besides, if the excuse were real, it would be repugnant that the party should know or remember what he did; but their heirs and executors may avoid such acts *in pais*, by pleading the disability; because, if they can prove it, it must be presumed real, since nobody can be thought to counterfeit it, when he can expect no benefit from it himself.

There are frequent instances in equity, where not only idiots and lunatics, who come within the protection of the law, but also persons of weak understandings have been relieved, when they appeared to have been imposed upon in their dealings, and unreasonable purchases, and securities obtained from them set aside in their favour. Idiots and lunatics, during their lunacy are incapable of making any will or testament, as are also persons grown childish by reason of extreme old age. So one actually drunk, if he be so drunk as to have lost the use of his reason: but though a person who wants understanding cannot make a will, yet the rule herein is not to be taken from his not being able to measure an ell of cloth, tell twenty, or the like, but whether he have sense enough to dispose of his estate with understanding.

When an idiot sues, or defends, he shall not appear by guardian, *prochein amy*, or attorney, but he must be ever in proper person: but otherwise of him who becomes *non compos mentis*; for he shall appear by guardian, if within age, or by attorney, if of full age.

JEER, or *Jeer-rope*, in a ship, is a large rope reeved through double or treble blocks, lashed at the mast-head, and on the yard, in order to hoist or lower the yards.

Jeers, or being brought to the jeers, in the sea-language, signifies a person's being punished at the jeer-capstan, by having his arms extended cross-wise, and tied to the capstan-bar when thrust through the barrel, and standing thus, with a heavy weight about his neck. In this posture he is obliged to continue, till he is either brought to confess some crime of which he is accused, or has suffered the punishment which the captain has sentenced him to undergo.

JEHOVAH, one of the Scripture names of God, signifying the Being who is self-existent, and gives existence to others. See the article God. So great a veneration had the Jews for this name, that they left off the custom of pronouncing it, whereby its true pronunciation was forgotten. They call it tetragrammaton, or the name with four letters; and believe, that whoever knows the true pronunciation of it cannot fail to be heard by God.

JEJUNUM, in anatomy, the second of the small intestines, so called because it is usually found empty. See Anatomy.

JESUITS, in church history, or the society of Jesus, a celebrated religious order in the Romish church, founded by Ignatius Loyoly, a Spaniard, who in the year 1738, assembled ten of his companions, at Rome, and proposed to form a new order, when it was agreed to add to the three ordinary vows of chastity, poverty, and obedience, a fourth, which was to go wherever the Pope should command, to make converts. They were admitted on their own terms; but the order was abolished, on account of the enormities committed by them, in 1773.

JET, a black, inflammable, bituminous substance, harder than asphaltum, and susceptible of a good polish; it becomes electrical by rubbing, attracting light bodies like yellow amber; it resembles cannel-coal in some particulars, as in hardness, re-

ceiving a polish, and not soiling the fingers by the touch. It has sometimes been confounded with this substance, but the distinction between them is not difficult: cannel-coal wants the electrical properties of jet, and is much heavier. Magellan supposed, that jet was true amber, differing from the yellow kind only in the circumstance of colour, and being lighter on account of the greater quantity of bituminous matter, which enters into its composition. It emits, in combustion, a bituminous smell; it is never found in strata or continued masses, like fossil-stones, but always in separate unconnected heaps, like true amber. It is found in abundance in the Pyrennean mountains; also in some parts of Portugal and Spain, in Sweden, Prussia, Germany, Italy, and Ireland.

JET *d'eau*, a French term, frequently also used with us, for a fountain that casts up water to a considerable height in the air. A jet of water is thrown up by the weight of the column of water above its ajutage, or orifice, up to its source or reservoir; and therefore it would rise to the same height as the head or reservoir, if certain causes did not prevent it from rising quite so high. For first, the velocity of the lower particles of the jet being greater than that of the upper, the lower water strikes that which is next above it; and as fluids press every way, by its impulse it widens, and consequently shortens the column. Secondly, the water at the top of the jet does not immediately fall off, but forms a kind of ball or head, the weight of which depresses the jet; but if the jet be a little inclined, or not quite upright, it will play higher, though it will not be quite so beautiful. Thirdly, the friction against the sides of the pipe and hole of the ajutage, will prevent the jet from rising quite so high, and a small one will be more impeded than a large one. And the fourth cause is the resistance of the air, which is proportional to the square of the velocity of the water nearly; and therefore the defect in the height will be nearly in the same proportion, which is also the same as the proportion of the heights of the reservoirs above the ajutage. Hence, and from experience, it is found that a jet, properly constructed, will rise to different heights, according to the height of the reservoir, as in the following table of the heights of reservoirs, and the heights of their corresponding jets; the former in feet, and the latter in feet, and tenths of a foot.

HEIGHTS OF RESERVOIRS AND THEIR JETS.

Res.	Jet.	Res.	Jet.	Res.	Jet.
5	4.9	31	28.3	57	49.0
6	5.9	32	29.2	58	49.7
7	6.8	33	30.0	59	50.5
8	7.8	34	30.8	60	51.2
9	8.7	35	31.6	61	52.0
10	9.7	36	32.5	62	52.7
11	10.6	37	33.3	63	53.5
12	11.6	38	34.1	64	54.2
13	12.5	39	34.9	65	54.9
14	13.4	40	35.7	66	55.7
15	14.3	41	36.6	67	56.4
16	15.2	42	37.4	68	57.1
17	16.1	43	38.1	69	57.8
18	17.0	44	38.9	70	58.6
19	17.9	45	39.8	71	59.3
20	18.8	46	40.5	72	60.0
21	19.7	47	41.3	73	60.7
22	20.6	48	42.1	74	61.4
23	21.5	49	42.9	75	62.1
24	22.3	50	43.7	76	62.8
25	23.2	51	44.4	77	63.5
26	24.1	52	45.2	78	64.2
27	24.9	53	46.0	79	64.9
28	25.8	54	46.7	80	65.6
29	26.6	55	47.5		
30	27.5	56	48.2		

JETSAM, any thing thrown out of a ship, being in the danger of wreck, and by the waves driven to the shore. See FLOTSAM.

JETTY *head*, a name given to that part of a wharf which projects beyond the rest, but more particularly the front of the wharf, whose side forms one of the cheeks of a wet or dry dock.

JEWEL *blocks*, two small blocks which are suspended at the extremity of the main and fore-top-sail yards, by means of an eye-bolt driven from without into the middle of the yard-arm parallel to the axis. The use of these blocks is to retain the upper part of the top-mast studding-sails beyond the sheets of the top-sails, so that each of these sails may have its full force of action, which would be diminished by the encroachment of the other over its surface.

JEWS, in church history, the descendants of Judah, the son of Jacob, and of the Israelites, commonly denominated the Twelve Tribes of Israel. This name was first given to those Jews who returned from the captivity of Babylon, because the tribe of Judah made the most conspicuous figure among them.

Our account of this people must be confined to their modern history, and to a brief statement of their present improved condition on the Continent, chiefly under the auspices of Buonaparte one of the most extraordinary characters that ever appeared in the world.

From the reign of Adrian, emperor of Rome, to the present day, the people of the Jewish nation have often been the dupe of some pretender to Messiahship, who has risen up to promise them that restoration to their former dignity and importance from which they have been driven by the imperious decrees of a righteous providence. It appears that about twenty-four false Christs have, at various times, excited the hopes and disappointed the expectations of this credulous and superstitious people. The most important of these Messiah's was one Zabathai Tzevi, who, in the year 1666, a year of great expectation by many, made a considerable noise at Smyrna, and other places. He was a man of much learning, and promised fairly to realize their expectations of being restored to their ancient inheritances and of becoming, once more a great and prosperous nation. Thousands of the Jews listened to his pretensions; but all his schemes were rendered abortive by an unfortunate difference that arose between him and one Nehemiah, who pretending to be the son of Ephraim, and whom he said was to be a kind of secondary Messiah, reproved his superior in the office of Messiahship, Zabathai, for his too great forwardness in appearing as the son of David, before the son of Ephraim had led him the way. Zabathai could not brook this doctrine, and therefore excluded his officious forerunner from any part or share in the matter. Nehemiah, mortified at his degradation, reported Zabathai to the Grand Seignior, at Adrianople, as a person dangerous to the government. Zabathai, dejected and fearful, appeared according to a summons for that purpose, before the Grand Seignior, who requiring a miracle, which was that the pretended Messiah should be stripped naked, and set as a mark for the archers to shoot at; and if the arrows did not pierce his flesh, he would own him to be the true Messiah. Zabathai's faith failed him; he sacrificed his pretensions to his life; and preferring the faith of the Musselmans to the arrows of the executioners, he furnished his disappointed followers with another proof of their foolish credulity, and the christian prophesies with additional confirmation.

The last of the pretended Christs, that made any considerable number of converts, was one Rabbi Mordechai, a Jew of Germany. He made his appearance in the year 1682. It was not long before he was found out to be an imposter, and was obliged to fly from Italy to Poland to save his life. What became of him afterwards is not known.

After this the most intelligent among the Jews seem to have turned their expectations rather towards a moral and political regeneration than to their restoration, as a people, to the city of Jerusalem, and to the actual repossession of Palestine, as their inheritance, though there are doubtless multitudes among them who still expect even this local restoration, and live constantly looking for some person to be raised up as their king and deliverer. Whatever may be the ideas of the Israelites in this country, it it certain their brethren on the Continent look up to the French Emperor, as their great promised deliverer and saviour. "The time of our trial," say they, "is expired, the period of our calamities is ended! All the persecutions we have sustained have only tended to unite us the more closely together. We have at all times remained faithful to the commandments of the Lord our God: for our recompense he has determined in his wisdom that we shall be received into the bosom of other nations, to enjoy the happiness of our forefathers: but to fulfil this object, it was necessary to find a man, whose virtues, whose valour and wisdom should exceed every thing which had been before admired by mortals! Napoleon appeared! and God Almighty immediately supported him with the arm of his power. He recalled him from Egypt, while he subjected the tempestuous ocean to his divine laws: he sent his angels to guide his steps, and to watch over his precious life: his divine spirit inspired this hero in the field of battle as in the midst of his palace: from the summit of the hills and mountains he shewed him his enemies, dispersed in the plains of Austerlitz and Jena." Thus are the riches and fire of oriental genius, conjoined with the warmth of adulation peculiar to the French people, made to express the hopes and enjoyments of the children of Israel! This is an epoch in the Jewish history deserving a more minute detail, and worthy of being preserved from the

perishing annals of newspapers and pamphlets. Posterity will see how far these flattering prospects have been built on a permanent or a sandy foundation.

In May, 1806, was issued, by the French Emperor, the following very extraordinary decree concerning the Jews.

"*Palace of St. Cloud*, May 30, 1806.

"Napoleon, Emperor of the French, and King of Italy.

"Accounts having reached us, that in several of the Northern departments of our empire, certain Jews, not exercising any other profession than that of usury, have, by extorting an enormous interest, reduced a number of farmers to a state of very great distress: we have conceived it our duty to succour such of our subjects, as have been reduced to these sorrowful extremes by an unjustifiable avarice. These circumstances have, at the same time, furnished us with an opportunity of knowing the urgent necessity of re-animating the sentiment of civil morality among those persons who profess the Jewish religion in the countries under our jurisdiction; sentiments which unhappily have been extinguished among a great number of them in consequence of the state of debasement under which they have long languished, which it has never entered into my views either to maintain or renew. For the accomplishment of this design, we have resolved to collect the principal persons among the Jews in an assembly; and then, through the means of commissioners, whom we shall nominate for the purpose, to communicate our intentions; and who will, at the same time, learn their wishes in respect to such manner as they may deem most expedient to awaken among their brethren the exercise of the arts and useful professions of life, in order that an honest industry may take the place of those scandalous resources to which many persons among the Jews have given themselves up, from the father to the son, for several years past. To this end, and upon the report of our Grand Judge, Minister of Justice, our Minister of the Interior, our Council of State, &c. we declare as follows:

"1. The execution of all contracts or actions against farmers, not merchants, shall be suspended for one year, reckoning from the date of the present decree, simple conservatory acts excepted; such farmers belonging to the departments of Le Sarre, Roer, Mont Tonnere, Haut, and Bas Rhin, Rhin and Moselle, Moselle and Vosges, in cases where they have been granted in favour of the Jews. 2. On the 13th of July next, an assembly of individuals professing the Jewish religion shall be held in our good city of Paris. This assembly is to be formed of those Jews only who inhabit the French territory. 3. The members shall be regulated according to the table hereunto annexed, taken from the various departments, and selected by the prefects from among the Rabbins, proprietors of land, and other Jews the most distinguished by their probity and intelligence. 4. In the other departments of our empire, not named in the annexed table, should any individuals be found professing the Jewish religion, to the number of one hundred and less than five hundred, the Prefect shall select a deputy for five hundred; and above that number to one thousand, two deputies; and so on in proportion. 5. The deputies chosen shall be at Paris before the 10th of July, and shall announce their arrival, and their place of residence, to the Secretary of our Minister of the Interior, who shall inform them of the place, the day, and the hour when the assembly shall meet. Our Minister of the Interior is charged with the execution of the present decree." Here follows a list of the deputies, being seventy-four in number.

These deputies accordingly assembled at Paris on July the 15th 1806, and were met by the Emperor's Commissioners. At their second sitting, the Commissioners put several questions to them, relative to the internal economy of the Jewish nation, and their ideas of the allegiance due from the Jews to the French government. The questions were generally answered in favour of the French. At this meeting a letter was read from M. Jacobsohn, Agent of the Finances at the court of Brunswick, addressed to Bonaparte. This letter was expressive of the gratification he felt in the interest which the Emperor of the French had shown towards the people of the Jews in France, and praying his Imperial Majesty to extend the like favour and indulgence to the Israelites inhabiting the countries adjoining the French Empire, and in particular to those of Germany.

On the 18th of September the Commissioners again proceeded to the Jewish assembly. At this assembly the Deputies were assured of the satisfaction which their answer had given his Imperial Majesty; and at the same time declared, that it was the

wish of the Emperor to ensure to them the free exercise of their religion, and the full enjoyment of their political rights. In return for this protection, the Emperor declared it his intention to exact from the Jews a religious guarantee for the entire observance of the principles announced in their answers. For this purpose, it was deemed requisite to constitute a Grand Sanhedrin, that their engagements of loyalty, attachment, &c. might have the most permanent sanction that could possibly be given to them. This was a most august design, and promised a high day for the poor scattered and despised children of Israel. The restoration of an assembly which had but seldom been convoked since it pronounced the sentence of condemnation, at Jerusalem, upon the Saviour of the world, excited the astonishment, and rouzed the jealousy, of the prejudiced and the vindictive, while it called forth the energies, and demanded the admiration, of not only the Jews, but of the greater part of all enlightened and reflecting Christians. Now it was that the scattered sheep of the House of Israel should again have a voice among their fellow-men; their declarations, as citizens, should henceforth be placed by the side of the Talmud; and they should, at length be constrained to acknowledge the authority of the laws of their country, under the awful and imposing obligations of morality and religion. This was regarded as the prelude to consequences still more important and flattering; perhaps, indeed, to nothing less than the speedy arrival of that period when they should again worship under their own vine and their own fig-tree, and none dare to make them afraid.

After assurances of liberty and protection on the one hand, and of gratitude and obedience on the other, it was agreed that a Grand Sanhedrin should be opened at Paris, at which should be preserved, as much as possible, the ancient Jewish forms and usages. This momentous event was announced to the dispersed remnant of the descendants of Abraham in a most grateful and pathetic address to the Jewish nation throughout France and Italy, which contained suitable advice, that the brethren would choose men known for their wisdom, the friends of truth and of justice, and capable of concurring in the great work there before them, and of giving the Grand Sanhedrin a sufficient degree of weight and consideration. The address concludes thus: "The sovereign Arbiter of nations and of kings has permitted this empire to cicatrize its wounds, to restore that tranquillity which continued storms had interrupted, to aggrandize its destiny, to fix ours, and to give happiness to two nations, who must ever applaud him, to whom has been confided the care of their happiness after that of their defence. Paris, 24th Tishri, 5567." (6th Oct. 1806.)

This address was shortly after answered by one of concurrence and congratulation from the people of the Jewish nation at Francfort on the Main; and the Prince Primate of Francfort, following the French Emperor's example, put an end to every humiliating distinction between the Jews of that city and the Christian inhabitants. The Israelites soon began to manifest the happy consequences of their emancipation by considerable improvements in education and the useful arts.

The Grand Sanhedrin assembled on Monday the 9th of February, 1807, while the number and distinction of the spectators added much to its solemnity. Reciprocal assurances of encouragement, congratulation, and thankfulness were exchanged, and this august assembly proceeded to make several important regulations relative to the Jewish worship and economy. Numerous addresses were read, and the most encouraging orations were delivered, while the great synagogue in the street St. Avoie resounded the praises of the God of Israel, amid repeated cries of *L'Empereur, L'Imperatrice! La Famille Imperiale!* and *La brave Armee Françoise!* It might be said of these Israelites, as it was once observed of their ancestors, that "all the people worshipped God, and the King."

Twenty-seven articles were drawn up and agreed to for the re-organization of the Mosaic worship. Sundry regulations were also made concerning polygamy, divorce, marriage, moral relations, civil and political relations, useful professions, loans among Israelites, and loans between Israelites and those who are not Israelites.

On the 2d of March the Grand Sanhedrin again sat, and passed a law for the condemnation of usury among the Jews. A most animated discourse was delivered in the Hebrew tongue by M. David Sintzheim, President of the Grand Sanhedrin. Translations of the discourse, in French and Italian, were afterwards read to the members assembled. A copy of this discourse, and of the whole of the proceedings of the Sanhedrin, have been preserved

in a publication of considerable interest, a small volume, lately published, entitled, "New Sanhedrin, and Causes and Consequences of the French Emperor's Conduct towards the Jews," written, we believe, by William Hamilton Reid. To this work we refer our readers for all the information necessary on this interesting subject.

Flattering, however, as these proceedings are to the Jews on the continent, it is certain that their brethren on this side the water look upon the conduct of the House of Israel in France, Italy, Holland, &c. with a jealous and suspicious eye. And it must be confessed, that to secure the blessings and rights of citizens, they have made sacrifices and concessions which seem but ill to accord with the due observance of that law which subjoins, that if a man offend in one point, he is guilty of all. That the restoration promised to this people is to be considered of a moral and political nature we think cannot be doubted. Such indeed was the opinion of the learned Bp. Warburton. Whether the regulations and decrees that have been passed in their favour in France are to be considered as the commencement of this restoration, time alone can determine. This much is evident, that in the restoration of Israel it is said, that every man should possess his own vine and his own fig-tree; but if the Jews are either prohibited the occupation, or excused the cultivation of land, this can never be the case; and this consideration, among others, seems to have suggested an idea to Buonaparte, that his Jewish subjects ought to be constrained to assist in the cultivation of the land, and in furnishing their quota of active conscripts for the defence of his dominions and of their own property. Their improved state, on the Continent, in a political point of view, seems not to have been attended with a correspondent degree of moral regeneration; and the French Emperor appears still to be dissatisfied with their way of life. The last decree issued concerning them was the 17th of March, 1808, which forbids them, indiscriminately, to pursue their speculations, and excuse themselves from honest labour. To partake of the fruits of the earth in his large dominions, they must also till the ground. The rich are called upon to purchase rural property, and to abandon the low pursuits of sordid avarice. This decree also annuls all obligations for loans made by Jews to minors, without the sanction of their guardians; to married women without the consent of their husbands; or to military men, without the authority of their superior officers. Bills granted by French subjects to Jews, cannot be demanded, unless their holders prove that the full value was given without any fraud. All debts accumulated by interest above five per cent., are to be reduced by the courts of law; if the interest growing on the capital exceed twenty-three per cent., the contract is to be declared usurious. No Jew is to be allowed to trade without a patent, which patent is to be granted to such individuals only who produce a certificate to the Prefects that they are no usurers. These regulations are to be continued during ten years only "in the hope, that after that period, there will be no difference between the moral character of the Jews and the other citizens of the empire." If the contrary shall appear, the law will be continued in force. It is doubtful whether the faith of the children of Israel, in Bonaparte as their reigning Messiah, will not be a little staggered by these regulations. Bonaparte has had the following return made to him of the number of Jews in all the different parts of the habitable globe: *viz.* In the Turkish empire one million; in Persia, China, and India, on the east and west of the Ganges, three hundred thousand; and in the west of Europe, Africa, and America, one million seven hundred thousand; making an aggregate population of three millions. One third of this number are already under the dominion of the French empire. For an account of the Jewish ceremonies, &c. see the late Mr. David Levi's work on that subject.

The following is a summary of their religious creed: 1. That God is the creator and active supporter of all things. 2. That God is ONE, and eternally unchangeable. 3. That God is incorporeal, and cannot have any material properties. 4. That God shall eternally subsist. 5. That God is alone to be worshipped. 6. That whatever has been taught by the prophets is true. 7. That Moses is the head and father of all contemporary doctors, and of all those who lived before, or shall live after him. 8. That the law was given by Moses. 9. That the law shall always exist, and never be altered. 10. That God knows all the thoughts and actions of men. 11. That God will reward the observance, and punish the breach of his laws. 12. The Messiah is to come, though he tarry a long time. 13. That there shall be a resurrection of

the dead when God shall think fit. These doctrines, commonly received by the Jews to this day, were drawn up about the end of the eleventh century, by the famous Jewish rabbi, Maimonides.

Here in England, in former times, the Jews and all their goods belonged to the chief lord where they lived; and he had such an absolute property in them, that he might sell them; for they had not liberty to remove to another lord without leave. They were distinguished from the Christians in their lives, and at their deaths; for they had proper judges and courts, where their causes were decided. By stat. Edward I. the Jews, to the number of 15,000, were banished out of England; and never returned, till Oliver Cromwell re-admitted them. Whenever any Jew shall present himself to take the oath of abjuration, in pursuance of the 10 George III. c. 10, the words—upon the true faith of a Christian—shall be omitted out of the oath in administering it to such persons; and the taking the oath, by persons professing the Jewish religion, without these words, in like manner as Jews are admitted to give evidence in the courts of justice, shall be deemed a sufficient taking of the abjuration-oath, If Jewish parents refuse to allow their Protestant children a maintenance suitable to their fortune, the Lord Chancellor, upon complaint, may make such order therein as he may think proper.

Jews' *harp*, in music, an instrument well known among the lower classes in this country, but almost the only musical instrument made use of by the inhabitants of the island of St. Kilda.

IGNATIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Apocineæ, Jussieu. Essential character: calyx five-toothed; corolla funnel-form, very long; fruit one-celled, many-seeded. There are two species. *viz.* I. amara, and I. longiflora.

IGNITION, in chemistry, is that illumination, or emission of light, produced in bodies by exposing them to a high temperature, and which is not accompanied by any other chemical change in them. It may be distinguished from combustion, a process in which there is also the emission of light and heat. Combustion is the result, not of mere increase of temperature in the body which suffers it, but of the chemical action of the air, or of a principle which the air contains: hence combustible substances are alone susceptible of it, and when the process has ceased, the body is no longer combustible. Ignition is an effect of the operation of caloric alone; it is wholly independent of the air; all bodies, at least solid and liquid substances, are equally susceptible of it, and if it has ceased, from a reduction of temperature, it may be renewed by the temperature being again raised. The point of temperature at which the first stage of ignition takes place, or at which bodies arrive at a red heat, appears to be the same in all, and is supposed to be about 800° of Fahrenheit. By raising the temperature, the illumination becomes brighter, and the red light acquires a mixture of yellow rays. At length, by still increasing it, we come to the white heat, which is the highest state of ignition. Aeriform fluids are not brought into a state of illumination by heat. The phenomena are produced, not only by the application of heat, but likewise by friction and attrition.

JIB, in naval affairs, the foremost sail of a ship being a large stay-sail extended from the outer end of the bowsprit, prolonged by the jib-boom, towards the fore-top-mast-head. In cutters and sloops, the jib is on the bow-sprit, and extends towards the lower mast-head. The jib is a sail of great command with any side wind, but especially when the ship is close-hauled, or has the wind upon her beam; and its effort in turning her head to leeward is very powerful, and of great utility, particularly when the ship is working through a narrow channel. Jib-boom is a continuation of the bow-sprit forward, being run out from the extremity in a similar manner to a top-mast on a lower mast, and serving to extend the bottom of the jibs and the stay of the fore-top-gallant-mast.

JIGGER, in naval affairs, a machine consisting of a piece of rope five feet long, with a block at one end, and a sheave at the other, used to hold on the cable when it is heaved into the ship by the revolution of the windlass. This is particularly useful, when either slippery with mud or ooze, or when it is stiff and unweildy, in both which cases it is very difficult to stretch it back from the windlass by hand, which however is done with facility and expedition by means of the jigger.

ILEX, in botany, *holly*, a genus of the Tetrandria Tetragynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx four-toothed; corolla wheel-shaped; style none; berry four-seeded. There are sixteen species,

This genus consists of small trees or shrubs, with alternate leaves, evergreen, toothed, or thorny; and axillary, many-flowered peduncles. I. aquifolium, common holly, is usually from twenty to thirty feet in height, though it sometimes exceeds sixty feet; the trunk is covered with a greyish bark, and those trees which are not lopped or browzed by cattle, are commonly furnished with branches, the greatest part of their length forming a sort of cone. Mr. Millar says, the difference of sexes in the flowers of the holly was first observed by his father. In his garden at Streatham in Surrey, he had many of these trees, which before he had possession of the place, were shorn into round heads; he emancipated them from their slavery, pruned them, and trained up leading shoots; seemingly glad to be released from their shackles, they quickly rewarded him with this discovery, concerning the nature of their flowers, which he communicated to the Royal Society. He perfectly recollects having carefully attended to the flowering of these trees during several seasons, and having uniformly observed hermaphrodite flowers on some, and male flowers on others: in the former the anthers were different from those in the male flowers, and appeared to be effete, and there never was a single male flower mixed with the hermaphrodite, or a hermaphrodite with the males, or any flower except the two here described.

The holly makes an impenetrable fence, and bears cropping well, nor is its verdure, or the beauty of its scarlet berries, ever observed to suffer from the severest of our winters. Mr. Evelyn's impregnable holly-hedge, four hundred feet in length, nine feet high, and five in diameter, has been much celebrated by himself, Ray, and others.

The wood of this tree is the whitest of all hard woods, and used by the inlayer, especially under thin plates of ivory. The mill-wright, turner, and engraver, prefer it to any other; it also makes the best handles and stocks for tools, flails, the best riding rods and carter's whips; bowls, chivers, and pins for blocks; Mr. Millar says, it is made into hones for setting razors; that the wood taking a fine polish, is proper for several kinds of furniture; that he has seen the floor of a room laid in compartments with this and mahogany, which had a very pretty effect.

It is much used with box, yew, and white thorn, in the small trinkets and other works, carried on, in, and about Tunbridge, commonly called Tunbridge ware.

Sheep and deer are fed during the winter with the croppings. Birds eat the berries. The bark fermented, and afterwards washed from the woody fibres, makes the common birdlime. Forty or fifty varieties, depending on the variegations of the leaves or thorns, and the colour of the berries, all derived from this one species, are raised by the nursery gardeners for sale, and were formerly in great esteem, but since the old taste of filling gardens with shorn evergreens has been laid aside, they are less regarded; a few however of the most lively varieties have a good effect in the winter season.

ILIUM, in anatomy, the third and last of the small intestines. See ANATOMY.

ILLECEBRUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Holoraceæ. Amaranthi, Jussieu. Essential character: calyx five-leaved, cartilaginous; corolla none; stigma simple; capsule five-valved, one-seeded. There are twenty-one species, natives of North and South America and the West India Islands.

ILLICIUM, in botany, a genus of the Polyandria Polygynia class and order. Natural order of Coadunatæ. Magnoliæ, Jussieu. Essential character: calyx six-leaved; petals twenty-seven; capsule several, disposed in a circle; bivalve one-seeded. There are two species, *viz.* I. anisatum, yellow-flowered aniseed tree; and I. floridanum, red-flowered aniseed tree. Both these plants bear a great resemblance to each other. Thurnberg doubts their being distinct species. The whole of the first mentioned plant, especially the fruit, has a pleasant aromatic smell, and a sweetish subacrid taste. In China it is in frequent use for seasoning dishes, especially such as are sweet. In Japan they place bundles and garlands of the aniseed tree in their temples before their idols, and on the tombs of their friends. They also use the powdered bark as incense to their idols. A branch put into the decoction of tetraodon hispidum is supposed to increase the virulence of the poison. The bark finely powdered is used by the public watchmen to make a chronometer or instrument for measuring the hours, by slowly sparkling at certain spaces in a box, in order to direct when the public bells are to sound.

ILLUMINATING, a kind of miniature painting, anciently much practised for illus-

trating and adorning books. Besides the writers of books, there were artists whose profession was to ornament and paint manuscripts, who were called illuminators; the writers of books first finished their part, and the illuminators embellished them with ornamented letters and paintings. We frequently find blanks left in manuscripts for the illuminators, which were never filled up. Some of the ancient manuscripts are gilt and burnished in a style superior to later times. Their colours were excellent, and their skill in preparing them must have been very great. The practice of introducing ornaments, drawings, emblematical figures, and even portraits, into manuscripts, is of great antiquity. Varro wrote the lives of 700 illustrious Romans, which he enriched with their portraits, as Pliny attests in his "Natural History." Pomponius Atticus, the friend of Cicero, was the author of a work on the actions of the great men amongst the Romans, which he ornamented with their portraits, as appears in his life by Cornelius Nepos. But these works have not been transmitted to posterity. There are, however, many precious documents remaining, which exhibit the advancement and decline of the arts in different ages and countries. These inestimable paintings and illuminations display the manners, customs, habits, ecclesiastical, civil, and military, weapons and instruments of war, utensils and architecture of the ancients; they are of the greatest use in illustrating many important facts relative to the history of the times in which they were executed. In these treasures of antiquity are preserved a great number of specimens of Grecian and Roman art, which were executed before the arts and sciences fell into neglect and contempt. The manuscripts containing these specimens form a valuable part of the riches preserved in the principal libraries of Europe. The Royal, Cottonian, and Harleian Libraries, as also those in the two universities in England, the Vatican at Rome, the imperial at Vienna, the royal at Paris, St. Mark's at Venice, and many others. A very ancient MS. of Genesis, which was in the Cottonian Library, and almost destroyed by a fire in 1731, contained 250 curious paintings in water-colours. Twenty-one fragments, which escaped the fire, are engraven by the society of antiquarians of London. Without mentioning others, we may observe that Mr. Strutt, has given the public an opportunity of forming some judgment of the degree of delicacy and art with which these illuminations were executed, by publishing prints of a prodigious number of them, in his "Regal and Ecclesiastical Antiquities of England," and "View of the Customs, &c. of England." In the first of these works we are presented with the genuine portraits, in miniature, of all the kings, and several of the queens of England, from Edward the Confessor to Henry VII. mostly in their crowns and royal robes, together with the portraits of many other eminent persons of both sexes. The illuminators and painters of this period seem to have been in possession of a considerable number of colouring materials, and to have known the arts of preparing and mixing them, so as to form a great variety of colours: for in the specimens of their miniature paintings that are still extant, we perceive not only the five primary colours, but also various combinations of them. Though Mr. Strutt's prints do not exhibit the bright and vivid colours of the originals, they give us equally a view, not only of the persons and dresses of our ancestors, but also of their customs, manners, arts, and employments, their arms, ships, houses, furniture, &c. and enable us to judge of their skill in drawing. The figures in those paintings are often stiff and formal; but the ornaments are in general fine and delicate, and the colours clear and bright, particularly the gold and azure. In some of these illuminations the passions are strongly painted. After the introduction of printing, this elegant art of illuminating gradually declined, and at length was quite neglected.

IMAGE, in optics, is the appearance of an object made either by reflection or refraction. In all plane mirrors, the image is of the same magnitude as the object, and it appears as far behind the mirror as the object is before it. In convex mirrors, the image appears less than the object; and farther distant from the centre of the convexity, than from the point of reflection. By the following rule, the diameter of an image projected in the base of a convex mirror, may be found. "As the distance of the object from the mirror is to the distance from the image to the glass, so is the diameter of the object to the diameter of the image."

IMAGINATION, a power or faculty of the mind, whereby it conceives and forms ideas of things communicated to it by the outward organs of sense.

IMITATION, in literary matters, the

act of doing or striving to copy after, or become like to, another person or thing.

IMITATIVE, in music, a term applicable to that music which is composed in imitation of the effects of some of the operations of nature, art, or human passion, as the rolling of thunder, swiftness of lightning, agitation of the sea, bellowing of the winds or waves, &c. Imitation is likewise a technical term for a studied resemblance of melody between the several passages of the harmonical parts of a composition.

IMMATERIAL, something devoid of matter, or that is pure spirit: thus, God, angels, and the human soul, are immaterial beings.

IMMEMORIAL, in law, an epithet given to the time or duration of any thing, whose beginning we know nothing of. In a legal sense, a thing is said to be of time immemorial, or time out of mind, that was before the reign of King Edward II.

IMMENSITY, an unlimited extension, or which no finite and determinate space, repeated ever so often, can equal.

IMMERSION, that act by which any thing is plunged into water, or other fluid. See FLUID.

IMMERSION, in astronomy, is when a star or planet is so near the sun with regard to our observations, that we cannot see it; being, as it were enveloped and hidden in the rays of that luminary. It also denotes the beginning of an eclipse of the moon, or that moment when the moon begins to be darkened, and to enter into the shadow of the earth; and the same term is also used with regard to an eclipse of the sun, when the disk of the moon begins to cover it. In this sense emersion stands opposed to immersion, and signifies the moment wherein the moon begins to come out of the shadow of the earth, or the sun begins to show the parts of his disk which were hid before.

Immersion is frequently applied to the satellites of Jupiter, and especially to the first satellite; the observation whereof is of so much use for discovering the longitude. The immersion of that satellite is the moment in which it appears to enter within the disk of Jupiter, and its emersion the moment when it appears to come out.

The immersions are observed from the time of the conjuction of Jupiter with the sun, to the time of his opposition; and the emersions from the time of his opposition to his conjuction.

IMMUTABILITY, one of the divine attributes, founded on the absolute perfection of the deity.

The immutability of God is two-fold, physical and moral. The first consists in this, that the divine essence does not, nor possibly can, receive any alteration; and the moral immutability is founded on the perfection of his nature, whereby he always wills the same things, or such as are best on the whole.

IMPALED, in heraldry, when the coats of a man and his wife who is not an heiress are borne in the same escutcheon, they must be marshalled in pale; the husband's on the right side, and the wife's on the left: and this the heralds call baron and feme, two coats impaled.

If a man has had two wives he may impale his coat in the middle between theirs; and if he has had more than two, they are to be marshalled on each side of his in their proper order.

IMPALPABLE, that whose parts are so extremely minute that they cannot be distinguished by the senses, particularly by that of feeling.

IMPARLANCE, is a petition in court, for a day to consider or advise what answer the defendant shall make to the action of the plaintiff; being a continuance of the cause till another day, or a larger time given by the court, which is generally till the next term.

IMPASSIBLE, that which is exempt from suffering, or cannot undergo pain or alteration. The stoics place the soul of their wise men in an impassible, or imperturbable state.

IMPATIENS, in botany, a genus of the Syngenesia Monogynia class and order. Natural order of Corydales. Gerania, Jussieu. Essential character: calyx two-leaved: corolla five-petalled, irregular, with a cowled nectary; capsule superior, five-valved. There are twelve species, of which I. balsamina, garden balsam, is an annual plant, about a foot and a half in height, dividing into many succulent branches; leaves long and serrate; the flowers come out from the joints of the stem, upon slender peduncles, an inch in length, each sustaining a single flower. In its wild state it is two feet, or more, in height, round, hispid, juicy, with a white stem, and ascending branches. It is a native of the East Indies, China, Cochin-China, and Japan; the Japanese use the juice prepared with alum, for dying their nails red. By culture this plant is very much enlarged, and be-

comes very branching. Mr. Millar tells us he has seen the stem seven inches in circuit, and all the plants large in proportion, branched from top to bottom, loaded with its party-coloured flowers, thus forming a most beautiful bush. The varieties which cultivation has produced in this elegant flower are numerous.

I. noli tangere, common yellow balsam, is also an annual plant; during the day the leaves are expanded, but at night they hang pendant, contrary to what is observed in most plants, which from a deficiency of moisture, or a too great perspiration from heat, commonly droop their leaves in the day-time. When the seeds are ripe, upon touching the capsule they are thrown out with considerable force: hence the Latin name "*impatiens*" and "*noli tangere.*" The whole plant is considerably acrid, and no quadruped, except perhaps the goat, will eat it.

IMPEACHMENT, is the accusation and prosecution of a person in parliament, for treason, or other crime and misdemeanors. An impeachment, before the Lords, by the Commons of Great Britain, is a presentment to the most high and supreme court of criminal jurisdiction, by the most solemn grand inquest of the whole kingdom. A commoner cannot be impeached before the lords for any capital offence, but only for high misdemeanors; but a peer may be impeached for any crime. The articles of impeachment are a kind of bills of indictment, found by the house of commons, and afterwards tried by the lords, who are, in cases of misdemeanors, considered not only as their own peers, but as the peers of the whole nation. By stat. 12 and 13 Wm. c. 2. no pardon under the great seal, shall be pleadable to an impeachment by the commons in parliament; but the king may pardon after conviction.

IMPEACHMENT of *waste*, signifies a restraint from committing of waste upon lands and tenements; and therefore he that has a lease without impeachment of waste, has by that a property or interest given him in the houses and trees, and may make waste in them without being impeached for it, that is, without being questioned, or demanded any recompense for the waste done.

IMPEDIMENTS, in law, persons under impediments are those within age, under coverture, *non compos mentis*, in prison, or beyond seas: who by saving in our laws, have time to claim and prosecute the right, after the impediments removed, in case of fines levied, &c.

IMPENETRABILITY, in philosophy, that property of body, whereby it cannot be pierced by another: thus, a body, which so fills a space as to exclude all others, is said to be impenetrable. Or, by impenetrability is meant the faculty which a body has of excluding every other body from the place that it occupies, in such manner that two bodies placed in contact can never occupy less space than that which they filled when they were separate. The impenetrability of solid bodies does not require to be proved, it strikes us at first view; but fluids, having their particles perfectly moveable in every direction, and yielding to the slightest pressure, their impenetrability does not manifest itself so perceptibly as that of solid bodies. Taking the air for an example: so long as this fluid is not enclosed in something, its extreme mobility causes it to admit a free passage to all bodies which are moved through it; but in this case it is properly displaced, and not penetrated; for, if the air be included within the sides of a vessel, and another body be then presented to take its place, without suffering it to escape, it will exercise its impenetrability in the same manner as solid bodies. It is easy to be convinced of this by the aid of a very simple experiment, which any one may make: it consists in plunging a vessel vertically, with the orifice downwards, in another vessel filled with water to a certain height: the surface of the water corresponding with the orifice of the first vessel, is depressed as this vessel itself descends; and this depression may be rendered more sensible by means of a little plate, or slip of cork, placed so as to float upon the surface of the water; nevertheless this water is not excluded by the air occupying the immersed vessel; it is always raised within it by a certain quantity, which augments as the vessel is immersed to a greater depth: but it is sufficiently evident that this ascension is occasioned by the circumstance that the air is a compressible fluid, and therefore its volume is contracted into a smaller space, by the effect of the compression excited upon it by the surrounding water on all parts, in virtue of its weight. We must here notice a difficulty which appears to result from this, that when we have mingled certain bodies, the volume of the mixture is less than the sum of the volumes taken separately. This happens, for example, when we mix equal parts of

alcohol and water; the same also obtains when we mingle, by fusion, copper with zinc, in order to form the compound metal called brass: it is then observed that the density of the mixture is augmented by about its tenth part. This apparent penetration is owing to the circumstance that the moleculæ of the two bodies, in consequence of their respective formation, generally approach one another more than in the two bodies taken separately: there hence results, in the figure of the pores, such a change as diminishes the space equal to the sum of these pores. On the contrary, in the alloy of silver with copper, a kind of rarefaction is produced, such that the volume of the mixture is larger than the sum of the volumes of the two bodies, previous to fusion.

IMPERATIVE, one of the moods of a verb, used when we would command, entreat, or advise: thus, *go, read, take pity, be advised,* are imperatives in our language.

IMPERATORIA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: fruit roundish, compressed, gibbose in the middle, surrounded by a margin; petals inflex, emarginate. There is but one species, *viz.* I. ostruthium, master-wort, the root of which is thick, running obliquely in the ground; it is fleshy, aromatic, and has a strong acrid taste, biting the tongue and mouth; the leaves arise immediately from the root, having foot-stalks seven inches long, divided into three very short ones at the top, each sustaining a trilobate leaf, indented on the border; the foot-stalks are deeply channeled, and when broken emit a rank odour; the flower-stalks rise two feet high, dividing into two or three branches, each terminated by a pretty large umbel of white flowers, whose petals are split; these are succeeded by oval compressed seeds, resembling those of dill, but larger. Linnæus observes, that the floral leaves are opposite, that there is a petiolary, membranaceous, ventricose, stipule, one within another. It is a native of many parts of the Alps, Austria, Syria, Tyrol, Silesia, and Dauphine.

IMPERFECT, something that is defective, or that wants some of the properties found in other beings of the same kind: thus mosses are called imperfect plants, because almost all the parts of fructification are wanting in them; and for the like reason is the appellation imperfect given to the fungi and submarine plants.

Imperfect *numbers*, such whose aliquot parts taken together do either exceed, or fall short of that whole number of which they are parts: they are either abundant or deficient. Thus 12 is an abundant imperfect number, because the sum of its parts $1 + 2 + 3 + 4 + 6 = 16$, which is greater than 12. But 10 is a deficient imperfect number, because $1 + 2 + 5 = 8$ only, which is less than 10.

IMPERSONAL *verb*, in grammar, a verb to which the nominative of any certain person cannot be prefixed; or, as others define it, a verb destitute of the two first and primary persons.

IMPETIGENES, in medicine, descriptive of those disorders which, from a general bad habit, manifest themselves principally by disfiguring the skin and external parts of the body.

IMPETUS, in mechanics, the force with which one body impels or strikes another.

IMPLEAD, to sue or prosecute by course of law.

IMPLICATION, in law, is where the law implies something that is not declared between parties in their deeds and agreements, and when our law gives any thing to a man, it gives by implication whatever is necessary for enjoying it. An implied contract is such, where the terms of agreement are not expressly set forth in words, but are such as reason and justice dictate, and which therefore the law presumes that every man undertakes to perform. Estates often arise by implication in a will, and sometimes in a deed; but they are more readily implied in the former than in the latter in which the words must be more strict.

IMPONDERABLE *substances.* See Substances, *imponderable.*

IMPORTATION, the act of bringing goods into a country from foreign parts. It has generally been considered, that for any country to carry on a profitable trade, it is necessary that the value of the goods sent out of it should be greater than that of the articles imported; this, however, is a very erroneous axiom, unless it is understood with great limitations. All articles of merchandize, imported merely for re-exportation, and also such as are used or worked up in our own manufactures, are far from being hurtful to our commerce, and may even, in many respects, be deemed of equal profit with our own native commodi-

ties. It is therefore an excess of such importations alone, as are either for mere luxury, or mere necessity, or for both together, which is disadvantageous to the country, and not such importations as, like many of ours, consist of raw silk, Spanish wool, cotton wool, and yarn, mohair, flax and hemp, oils, potash, dyeing stuffs, naval stores, &c. either used in our ship-building, or worked up in our manufactures, a principal part of which are for exportation: neither can our importations of East India goods and colonial produce, which are chiefly designed to be afterwards exported, be deemed unprofitable, but are, on the contrary, some of the most lucrative branches of our foreign trade. The following statement of the total value of the imports of England, in the year 1354, furnishes a good comparison with their present magnitude.

		£.	s.	d.
1831	Fine cloths, at 6*l.* per cloth, which, with the customs, come to	11,083	12	0
$397\frac{3}{4}$	Hundred weight of wax, at 40*s.* per hundred weight, which, with the customs, come to	815	7	5
$1829\frac{1}{2}$	Tons of wine, at 40*s.* per ton, which, with the customs, come to	3,841	19	0
	Linen cloth, mercery, grocery, and all other wares	22,943	6	10
	On which the customs were	285	18	3
	Total	38,970	3	6

At this period, and for a long time after, foreigners were the principal importers of goods in this country; and as it was thought that many of them, after disposing of their merchandize here, returned with the value in money to their own country, which was deemed a serious injury, many laws were made against carrying out of the realm any gold or silver, either in coin, plate, or bullion; and merchant strangers were compelled to give security that they would lay out all the money they received for the wares they imported, in English merchandize to be exported. These injudicious restrictions have been long since done away, and, excepting the prohibition of some foreign manufactures, the import trade of this country is probably as free as the regulations necessary to secure the payment of heavy duties on almost every article of trade will admit. Total official value of the imports of Great Britain in the year 1800.

	£.	s.	d.
Port of London	18,843,172	2	10
The Out Ports	9,514,642	11	10
England	28,357,814	14	8
Scotland	2,212,790	11	8
	30,570,605	6	4

In 1801	£32,795,556
1802	31,441,318
1803	27,992,464
1804	29,201,490
1805	30,344,628
1806	28,835,907
1807	29,556,330

These sums are the official value of goods imported, which is very different from the real value; as an instance which may serve for every case, the official value of the imports for 1807, 29,556,330*l.*; but the real value, according to the average of the last three years, is 53,500,990*l.*

IMPOSTHUME, a collection of matter or pus in any part of the body, either owing to previous inflammation of the part, or a translation of it from some other part.

IMPOSSIBLE *roots*, in algebra. To discover how many impossible roots are contained in any proposed equation, Sir I. Newton gave this rule in his algebra, *viz.* Constitute a series of fractions, whose denominators are the series of natural numbers, 1, 2, 3, 4, 5, &c. continued to the number showing the index or exponent of the highest term of the equations, and their numerators the same series of numbers in the contrary order; and divide each of these fractions by that next before it, and place the resulting quotients over the intermediate terms of the equation; then under each of the intermediate terms, if its square multiplied by the fraction over it, be greater than the product of the terms on each side of it, place the sign $+$; but if not, the sign $-$; and under the first and last term place the sign $+$. Then will the equation have as many imaginary roots as there are changes of the underwritten signs from $+$ to $-$, and from $-$ to $+$. So for the equation $x^3 - 4x^2 + 4x - 6 = 0$, the series of fractions is $\frac{3}{1}, \frac{2}{2}, \frac{1}{3}$: then the second, divided by the first, gives $\frac{2}{6}$ or $\frac{1}{3}$, and

the third divided by the second gives $\frac{1}{3}$ also; hence these quotients, placed over the intermediate terms, the whole will stand thus:

$$\begin{array}{cccc} & \frac{1}{3} & \frac{1}{3} & \\ x^3 & -4x^2 & +4x & -6. \\ + & + & - & + \end{array}$$

Now because the square of the second term, multiplied by its superscribed fraction, is $\frac{16}{3}x^4$, which is greater than $4x^4$, the product of the two adjacent terms, therefore the sign $+$ is set below the second term; and because the square of the third term, multiplied by its over written fraction, is $\frac{16}{3}x^2$, which is less than $24x^2$, the product of the terms on each side of it; therefore the sign $-$ is placed under that term; also the sign $+$ is set under the first and last terms. Hence the two changes of the underwritten signs $+ + - +$, the one from $+$ to $-$, and the other from $-$ to $+$, show that the given equation has two impossible roots. When two or more terms are wanting together, under the place of the first of the deficient terms write the sign $-$ under the second the sign $+$, under the third $-$, and so on, always varying the signs, except that under the last of the deficient terms must always be set the sign $+$, when the adjacent terms on both sides of the deficient terms have contrary signs. As in the equation.

$$\begin{array}{cccccc} x^5 & +ax^4 & * & * & * & +a^5 = 0, \\ + & + & - & + & - & + \end{array}$$

which has four imaginary roots.

IMPOSTS, in architecture, the capitals of pillars, or pilasters, which support arches. An impost, sometimes called chaptrel, is a sort of a plinth, or little corniche, which crowns a pier, and supports the first stone whence an arch or vault commences. The imposts are conformable to their proper orders. The Tuscan has only a plinth; the Doric has two faces crowned; the Ionic, a larmier, or crown over the two faces, and its mouldings may be carved; the Corinthian and Composite have a larmier, frieze, and other mouldings. See ARCHITECTURE.

IMPOTENCY, in the ecclesiastical law, signifies an inability of generation, or propagating the species, which is a cause of divorce a *vinculo matrimonii*, as being merely void, and therefore needs only a sentence declaratory of its being so.

IMPRESSING *men*. The power of impressing seamen for the sea-service, by the King's Commission, has been a matter of some dispute, and submitted to with great reluctance, though it has very clearly and learnedly been shown by Sir Michael Forster, that the practice of impressing, and granting power to the Admiralty for that purpose, is of very ancient date, and has been uniformly continued, by a regular series of precedents, to the present time, whence he concludes it to be part of the common law. The difficulty arises from hence, that no statute has expressly declared this power to be in the crown, though many of them very strongly imply it. The statute 2 Richard II. c. 4, speaks of mariners being arrested and retained for the King's service, as of a thing well known and practised without dispute, and provides a remedy against their running away. By statute 2 and 3 Philip and Mary c. 16, if any waterman who uses the river Thames, shall hide himself during the execution of any commission for pressing for the King's service, he is liable to heavy penalties. By statute 5 Elizabeth, c. 6, no fisherman shall be taken by the Queen's commission to serve as a mariner; but the commission shall be first brought to two justices of the peace inhabiting near the sea coast where the mariners are to be taken, to the intent that the justices may choose out, and return such a number of able bodied men as in the commission are contained to serve her Majesty. And by statute 7 and 8 William, c. 21; 2 Anne, c. 6; 4 and 5 Anne, c. 19; 13 George II. c. 17, especial protections are allowed to seamen in particular circumstances, to prevent them from being impressed. All which do most evidently imply a power of impressing to reside somewhere; and if any where, it must, from the spirit of our constitution, as well as from the frequent mention of the king's commission, reside in the crown alone. The Liverymen of London claim an exemption from being pressed; but by a late decision of the Court of King's Bench, this exemption is denied. Landmen, entering into the merchant service, and apprentices, are exempt for two years from the impress, and all apprentices to the sea-service under eighteen.

IMPRESSION denotes the edition of a book, regarding the mechanical part only; whereas edition, besides this, takes in the care of the editor, who corrected or augmented the copy, adding notes, &c. to render the work more useful.

IMPRISONMENT, is the restraint of a man's liberty under the custody of another, and extends not only to a gaol, but an house, stocks, or where a man is held in the

street, or any other place; for, in all these cases the party so restrained is said to be a prisoner, so long as he hath not his liberty freely to go about his business, as at other times. None shall be imprisoned but by the lawful judgment of his peers, or by the law of the land.

IMPROPRIATION, is properly so called, when a benefice ecclesiastical is in the hands of a layman, and appropriation when in the hands of a bishop, college, or religious house, though sometimes these terms are confounded. It is said there are three thousand eight hundred and forty-five impropriations in England.

IMPULSE, in mechanics, the single and instantaneous action or force by which a body is impelled, in contradistinction to the application of continued forces.

INACCCESSIBLE, something that cannot be come at, or approached, by reason of intervening obstacles, as a river, rock, &c. It is chiefly used in speaking of heights and distances. See SURVEYING.

INARCHING, in gardening, is a method of grafting, commonly called grafting by approach, and is used when the stock intended to graft on, and the tree from which the graft is to be taken, stand so near, or can be brought so near, that they may be joined together. The method of performing it, is as follows: take the branch you would inarch, and having fitted it to that part of the stock where you intend to join it, pare away the rind and wood on one side, about three inches in length. After the same manner cut the stock or branch in the place where the graft is to be united, so that the rind of both may join equally together; then cut a little tongue upwards in the graft, and make a notch in the stock to admit it; so that when they are joined, the tongue will prevent their slipping, and the graft will more closely unite with the stock. Having thus placed them exactly together, tie them with some bass, or other soft tying; then cover the place with grafting clay, to prevent the air from entering to dry the wound, or the wet from getting in to rot the stock: you should also fix a stake in the ground, to which that part of the stock, together with the graft, should be fastened, to prevent the wind from breaking them asunder, which is often the case, when this precaution is not observed. In this manner they are to remain about four months, in which time they will be sufficiently united, and the graft may then be cut from the mother tree, observing to slope it off close to the stock; and if at this time you cover the joined parts with fresh grafting-clay, it will be of great service to the graft.

IN AUTER DROIT, in another's right, as where executors or administrators sue for a debt or duty, &c. of the testator or intestate.

INCEST, is the carnal knowledge of persons within the Levitical degrees of kindred. These by our law, are totally prohibited to marry with each other; and sentence of divorce in such case, is only declaratory of the illegality of the marriage, for the marriage itself is void, *ab initio*.

INCH, a well known measure of length; being the twelfth part of a foot, and equal to three barley-corns in length. See MEASURE.

INCH *of candle*, or sale by inch of candle. See CANDLE.

INCHASING. See ENCHASING.

INCIDENCE, in mechanics, denotes the direction in which one body strikes on another. See MECHANICS and OPTICS.

It is demonstrated that the angle of incidence is equal to the angle of reflection, and that they both lie in the same plane. That the sines of the angles of incidence and refraction are to each other, either accurately or nearly, in a given or constant ratio: that from air to glass, the sine of the angle of incidence is to the sine of the angle of refraction as 14.9.

INCIDENT, signifies a thing necessarily depending upon another as more principal. For example, a court baron, is an incident to a manor, and a court of pye-powder to a fair, so inseparably that they cannot be severed by grant.

INCINERATION, in chemistry, a term applied to the burning of vegetables for the sake of their ashes: it is usually referred to the burning of kelp on the coasts for making mineral alkali.

INCLINATION, is a word frequently used by mathematicians, and signifies the mutual approach, tendency or leaning of two lines, or two planes towards each other, so as to make an angle. Inclination of a right line to a plane, is the acute angle, which that line makes with another right line drawn in the plane through the point where the inclined line intersects it, and through the point where it is also cut by a perpendicular drawn from any point of the inclined plane. Inclination of the axis of the earth, is the angle which it makes with the plane of the ecliptic; or the angle,

contained between the planes of the equator and ecliptic. Inclination of a planet, is an arch of the circle of inclination, comprehended between the ecliptic and the plane of a planet in its orbit. See ASTRONOMY.

INCLINED *plane*, in mechanics, one that makes an oblique angle with the horizon. If a force, with a given direction, supports a weight upon an inclined plane; that force is to the weight, as the sine of the inclination of the plane to the sine of the angle which is made by the line in which the force acts, and the line perpendicular to the plane. See MECHANICS.

INCLOSURES. Any person who shall wilfully or maliciously demolish, pull down, or otherwise destroy or damage, any fence raised or made for dividing or inclosing any common, waste, or other lands, in pursuance of any act of parliament, or shall cause or procure the same to be done, shall be guilty of felony, and transported for seven years. Prosecution to be commenced in eighteen months after the offence committed.

INCOMBUSTIBLE, something that cannot be burnt, or consumed by fire. Authors talk much of an incombustible cloth, made of the asbestus. See ASBESTUS.

INCOMBUSTIBLES, *simple*. See SUBSTANCES, *simple*.

INCOME *tax*, a direct contribution of a certain proportion of the annual gains of individuals for the public service, which has recently become an important branch of the revenue of Great Britain. An attempt was made in 1702 to levy a tax of this description; but it proved very unproductive, and therefore was discontinued. Towards the end of the year 1798, Mr. Pitt proposed, in lieu of the additional assessed taxes, a general tax on income, whether arising from land, personal property, or from any profession, office, trade, or other employment. The act was passed 9th January, 1799; and the duties imposed by it were, ten per cent. on all incomes of 200*l.* per annum and upwards, and lesser proportions on incomes between that amount and 60*l.* per annum, which paid a one-hundred-and twentieth part, or ten shillings per annum: incomes below 60*l.* a year were wholly exempt. The great object of this tax was, to raise a considerable proportion of the public supplies within the year, and to liquidate within a short time what might be further raised by loan; with the latter view the payment of the interest, and redemption of the capital, of part of the loans for the years 1798, 1799, and 1800, was charged on the produce of the tax; but it being a tax which from its commencement had been very unpopular, both from its weight and the disclosure of the circumstances of individuals with which it was attended, it was repealed in April, 1802, and the charges upon it transferred to the Consolidated Fund.

In 1803 the income tax was revived, with some alterations in the mode of collecting it, under the title of the property tax: the rate at which it was now imposed was 5 per cent. on all incomes above 150*l.* per annum, and lesser proportions on incomes between that amount and 60*l.* per annum. In 1805 it was increased to 6¼ per cent.; and in 1806 it was raised to the original rate at which it had been imposed, or 10 per cent., while the scale of lesser rates was made to comprehend all incomes amounting to 50*l.* per annum. By this means, and by deducting the tax on the dividends of the public funds at the Bank, and abolishing most of the former abatements and exemptions, the sum raised by it has been considerably augmented, the estimated produce being as follows:

1804 at 1*s.* in the pound	£4,650,000
1805 at 1*s.* 3*d.* ditto.......	5,937,500
1806 at 2*s.*....... ditto.......	11,500,000

An income tax, if it could be so regulated as to bear a just proportion to the different modes in which the incomes of individuals arise, and did not extend to such amounts of income as are absolutely necessary for subsistence, would become the most equitable, as well as the most productive mode of taxation.

INCOMMENSURABLE, a term in geometry, used where two lines, when compared to each other, have no common measure, how small soever, that will exactly measure them both. And in general two quantities are said to be incommensurable, when no third quantity can be found that is an aliquot part of both. Such are the diagonal and side of a square; for though each of those lines have infinite aliquot parts, as the half, the third, &c. yet not any part of the one, be it ever so little, can possibly measure the other, as is demonstrated in prop. 117. lib. x. of Euclid.

INCOMMENSURABLE *numbers* are such as have no common divisor that will divide them both equally.

INCOMPLETE, in botany, a term used to denote the sixteenth class of the Linnæan

"methodus calycina," consisting of plants whose flowers want either the calyx or petals.

INCORPORATION, *power of.* To the erection of any corporation the King's consent is necessary, either impliedly or expressly given: the King's implied consent is to be found in corporations which exist by force of the common law, to which our former kings are supposed to have given their concurrence; of this sort are all bishops, parsons, vicars, churchwardens, and some others, who by common law have ever been held to have been corporations by virtue of their office. Another method of implied consent is with regard to all corporations by prescription; such as the city of London, and many others, which have existed as corporations for time immemorial; for though the members thereof can show no legal charter of incorporation, yet in cases of such high antiquity the law presumes there once was one, and that by variety of accidents, which a length of time may produce, the charter is lost or destroyed. The methods by which the King's consent is expressly given are either by act of parliament or charter; but the immediate creative act is usually performed by the King alone, in virtue of his royal prerogative. See further JOINT STOCK.

INCREMENT, is the small increase of a variable quantity. Sir Isaac Newton calls these increases "moments," and observes, that they are proportional to the velocity or rate of increase of the flowing or variable quantities, in an indefinitely small time. The notation of increment is different by different authors. The method of increments, is a branch of analytics, in which a calculus is founded on the properties of successive values of variable quantities, and their differences, or increments. It is nearly allied to the doctrine of fluxions, and, in truth, arises out of it. Of the latter the great Newton was the inventor; of the former we have different treatises by Dr. Taylor, Mr. Emerson, and others. We shall give Mr. Emerson's observations on the distinction between the method of increments and fluxions. "From the method of increments," he says, "the principal foundation of the method of fluxions may be easily derived; for, as in the method of increments, the increment may be of any magnitude, so in the method of fluxions, it must be supposed infinitely small; whence all preceding and successive values of the variable quantity will be equal, from which equality the rules for performing the principal operations of fluxions are immediately deduced. That I may give the reader," continues he, "a more perfect idea of the nature of this method: suppose the abscissa of a curve be divided into any number of equal parts, each part of which is called the increment of the abscissa, and imagine so many parallelograms to be erected thereon, either circumscribing the curvilineal figure, or inscribed in it; then the finding the sum of all these parallelograms is the business of the method of increments. But if the parts of the abscissa be taken infinitely small, then these parallelograms degenerate into the curve; and then it is the business of the method of fluxions to find the sum of all, or the area of the curve. So that the method of increments finds the sum of any number of finite quantities; and the method of fluxions the sum of any infinite number of infinitely small ones: and this is the essential difference between these two methods."

Again: "There is such a near relation between the method of fluxions and that of increments, that many of the rules for the one, with little variation, serve also for the other. And here, as in the method of fluxions, some questions may be solved, and the integrals found, in finite terms; whilst in others we are forced to have recourse to infinite series for a solution. And the like difficulties will occur in the method of increments, as usually happen in fluxions. For whilst some fluxionary quantities have no fluents, but what are expressed by series, so some increments have no integrals but what infinite series afford; which will often, as in fluxions, diverge and become useless." By means of the method of increments, many curious and useful problems are easily resolved, which scarcely admit of a solution in any other way. As, suppose several series of quantities be given, whose terms are all formed according to some certain law which is given; the method of increments will find out a general series, which comprehends all particular cases, and from which all of that kind may be found. The method of increments is also of great use in finding any term of a series proposed: for the law being given by which the terms are formed, by means of this general law the method of increments will help us to this term, either expressed in finite quantities, or by an infinite series. Another use of the method of increments is to find the sum of series, which it will often do in finite terms. And when the sum of a

series cannot be had in finite terms, we must have recourse to infinite series; for the integral being expressed by such a series, the sum of a competent number of its terms will give the sum of the series required. This is equivalent to transforming one series into another, converging quicker: and sometimes a very few terms of this series will give the sum of the series sought. See Emerson's Increments.

INCUBUS, or *night mare*, in medicine, the name of a disease which consists in a spasmodic contraction of the muscles of the breast, usually happening in the night, and attended with a very painful difficulty of respiration and great anxiety.

INCUMBENT, a clerk diligently resident on his benefice with cure; and called incumbent of that church, because he does or ought to apply himself sedulously to discharge the duty of his cure.

INCURVATION *of the rays of light*, their bending out of a rectilinear or straight course, occasioned by refraction.

INDEFINITE, or INDETERMINATE, that which has no certain bounds; or to which the human mind cannot affix any. Des Cartes makes use of this word in his philosophy instead of infinite, both in numbers and quantities, to signify an unconceivable number, or a number so great that an unit cannot be added to it; and a quantity so great as not to be capable of any addition. Thus, he says, the stars visible and invisible are in number indefinite; and not as the ancients held infinite; and that quantity may be divided into an indefinite number of parts, not an infinite number.

INDEFINITE is also used in the schools to signify a thing that has but one extreme; for instance, a line drawn from any point and extended infinitely.

INDEFINITE, in grammar, is understood of nouns, pronouns, verbs, participles, articles, &c. which are left in an uncertain indeterminate sense, and not fixed to any particular time, thing, or other circumstance.

INDENTED, in heraldry, is when the out-line of an ordinary is notched like the teeth of a saw.

INDENTED *line*, in fortification, the same with what the French engineers call redent; being a trench and parapet running out and in, like the teeth of a saw; and is much used in irregular fortification.

INDENTURE, is a writing, containing a conveyance between two or more, indented or cut unevenly, or in and out, on the top or side, answerable to another writing that likewise comprehends the same words. Formerly when deeds were more concise than at present, it was usual to write both parts on the same piece of parchment, with some words or letters written between them, through which the parchment was cut, either in a straight or indented line, in such a manner as to leave half the word on one part, and half on the other; and this custom is still preserved in making out the indentures of a fine. But at last, indenting only hath come into use, without cutting through any letters at all, and it seems at present to serve for little other purpose, than to give name to the species of the deed.

INDEPENDENTS, or CONGREGATIONALISTS, in church history, a sect of Protestant Dissenters, which first made its appearance in Holland in the year 1616. Mr. John Robinson appears to have been the founder of this sect. The appellation of independents was applied to, and adopted by this denomination of Christians, from their maintaining that all Christain congregations are so many independent religious societies, having a right to be governed by their own laws, without being subject to any further or foreign jurisdiction. This term was publicly acknowledged in the year 1644, by those English Dissenters, who held similar sentiments respecting church government to the independents in Holland; but on account of the ill use that many made of the term, by a perversion of its original meaning and religious designation, the English Independents renounced it, and adopted that of Congregationalists, or Congregational Brethren. The term independent is still, however, applied to various sects of Protestant Dissenters, and seems justly applicable to almost every sect of nonconformists in this country.

The doctrines of the Independents are the same as those of the BROWNISTS. It is said that the only difference between these sects were, that the Brownists were illiberal in their views concerning other denominations, while the Independents entertained enlarged conceptions of church communion, and allowed that other churches though different from them in points of discipline, might properly be called Christian churches. It is, however, to be feared that the Independents, properly so called, being Calvinists as to points of faith, do not cherish very liberal sentiments concern-

ing the salvation of those who differ from them in most of their articles of belief. A spirit which seems to be a natural effect of the creed of the Geneva Reformer. See BROWNISTS and PRESBYTERIANS.

INDETERMINATE, in general, an appellation given to whatever is not certain, fixed, and limited; in which sense it is the same with indefinite.

INDETERMINATE *problem*, is that which admits of many different solutions and answers, called also an unlimited problem. In questions of this kind the number of unknown quantities concerned is greater than the number of the conditions and equations by which they are to be found; from which it happens that generally some other conditions or quantities are assumed to supply the defect, which being taken at pleasure, give the same number of answers as varieties in those assumptions. If, for instance, it were required to find the value of two square numbers, whose difference is equal to a, a given quantity. Here if x^2 and y^2 denote the squares then $x^2 - y^2 = a$, which is only one equation for finding two quantities. Now by assuming some other unknown quantity as z so that $z = x + y =$ the sum of the roots; then is $x = \frac{z^2 + a}{2z}$ for

$$\begin{aligned} x^2 - y^2 &= a \\ x^2 + 2xy + y^2 &= z^2 \\ \hline 2x^2 + 2xy &= z^2 + a \\ x = \frac{z^2+a}{2x+2y} &= \frac{z^2+a}{2z}. \end{aligned}$$

And by the same mode $y = \frac{z^2 + a}{2z}$, which are the two roots having the difference of their squares equal to a given quantity a, and are expressed by means of an assumed quantity z; so that there will be as many answers to the question, as there can be taken values of the indeterminate quantity z.

Mr. Leslie, in the transactions of the Royal Society of Edinburgh, has given a paper on this subject, the object of which is to resolve the complicated expressions which we obtain in the solution of indeterminate problems, into simple equations, and this is done by means of a principle, which, though extremely simple, admits of a very extensive application. Let $A \times B$ be any compound quantity equal to another, $C \times D$, and let m be any rational number assumed at pleasure; it is manifest that, taking equimultiples, $A \times m B = C \times m D$. If, therefore, we suppose that $A = m D$, it must follow that $m B = C$, or $B = \frac{C}{m}$. Thus two equations of a lower dimension are obtained. If these be capable of further decomposition, we may assume the multiples n and p, and form four equations still more simple. By the repeated application of this principle, an higher equation admitting of divisors, will be resolved into those of the first order, the number of which will be one greater than that of the multiples assumed. For example, resuming the problem at first given, *viz.* to find two rational numbers, the difference of the squares of which shall be a given number. Let the given number be the product of a and b; then by hypothesis, $x^2 - y^2 = ab$; but these compound quantities admit of an easy resolution, for $\overline{x + y} \times \overline{x - y} = a \times b$. If therefore we suppose $x + y = ma$, we shall obtain $x - y = \frac{b}{m}$ where m is arbitrary, and if rational, x and y must also be rational. Hence the resolution of these two equations gives the values of x and y, the numbers sought, in terms of m, *viz.* $x = \frac{m^2 a + b}{2m}$, and $y = \frac{m^2 a - b}{2m}$.

INDEX, in anatomy, the same with the fore finger. See FINGERS.

INDEX, in arithmetic and algebra, shows to what power any quantity is involved, and is otherwise called exponent. See EXPONENT.

INDEX *of a logarithm*, that which shows of how many places the absolute number, belonging to a logarithm, doth consist; and of what nature it is, whether an integer or fraction. Thus, in this logarithm 2.523421, the number 2 standing on the left hand of the point is called the index; because it shows that the absolute number, answering to the above logarithm, consists of three places: for the number is always one more than the index. If the absolute number be a fraction, then the index of the logarithm hath a negative sign, marked thus $\bar{2}.523421$. See LOGARITHM.

INDEX *of a globe*, the little style or gnomon, which being fixed on the pole of the globe, and turning round with it, points out the hours upon the hour circle. See GLOBE.

INDIA *rubber*. See COUTCHOUC.

INDICATIVE, in grammar, the first mood, or manner, of conjugating a verb, by

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which we simply affirm, deny, or ask something.

INDICTION, in chronology, a cycle of fifteen years. See CHRONOLOGY.

INDICTMENT, is a written accusation of one or more persons, of a crime or misdemeanor, preferred to, and presented on oath by, a grand jury. An indictment may be found on the oath of one witness only, unless it be for high treason, which requires two witnesses. And unless in any instance it is otherwise specially directed by acts of parliament. The sheriff of every county is bound to return to every session of the peace, and every commission of oyer and terminer, and of general gaol delivery, twenty-four good and lawful men, of the county, some out of every hundred, to enquire, present, do, and execute all those things, which, on the part of our lord the King, shall then and there be commanded therein. As many as appear upon this pannel are sworn of the grand jury, to the amount of twelve, at the least, and not more than twenty-three, that twelve may be a majority. This grand jury is previously instructed in the articles of their enquiry, by a charge from the judge on the bench. They then withdraw from court, to sit and receive indictments, which are preferred to them in the name of the King, but at the suit of any private prosecutor; and they are only to hear evidence on behalf of the prosecution; for the finding an indictment is only in the nature of an enquiry or accusation, which is afterwards to be tried and determined; and the grand jury are only to enquire, upon their oaths, whether there be sufficient cause to call upon the party to answer it.

The grand jury may not find part of an indictment true, and part false; but must either find a true bill, or ignoramus, for the whole; and if they take upon them to find it specially, or conditionally, or to be true for part only, and not for the rest, the whole is void, and the party cannot be tried upon it, but ought to be indicted anew.

All capital crimes whatsoever, and all kinds of inferior crimes, which are of a public nature, as misprisions, contempts, disturbances of the peace, oppressions, and all other misdemeanors whatsoever, of a public evil example, against the common law, may be indicted, but no injuries of a private nature, unless they in some degree concern the King. And generally, where a statute prohibits a matter of public grievance, to the liberties and security of a subject, or commands a matter of public convenience, as the repairing of the common streets of the town, &c., every disobedience of such statute is punishable, not only at the suit of the party grieved, but also by way of indictment, for contempt of the statute, unless such method of proceeding shall manifestly appear to be excluded by it. Yet if the party offending, have been fined in an action brought by the party (as it is said he may in every action, for doing a thing prohibited by statute); such fine is a good bar to the indictment, because by the fine the end of the statute is satisfied; otherwise he would be liable to a second fine for the same offence.

If several offenders commit the same offence, though, in law, they are several offences in relation to the several offenders, yet they may be joined in one indictment; as if several commit a robbery or murder.

No indictment for high treason, or misprision thereof, (except indictments for counterfeiting the King's coin, seal, sign, or signet), nor any process or return thereupon, shall be quashed for mis-reciting, misspelling, false, or improper Latin, unless exception concerning the same be taken, and made in the respective court where the trial shall be, by the prisoner or his counsel assigned, before any evidence given in open court on such indictment; nor shall any such mis-reciting, mis-spelling, false, or improper Latin, after conviction on such indictment, be any cause or stay, or arrest of judgment; but nevertheless any judgment on such indictment shall be liable to be reversed on writ of error, as formerly. An indictment accusing a man in general terms, without ascertaining the particular fact laid to his charge, is insufficient; for no one can know what defence to make to a charge which is uncertain, nor can plead it in bar on abatement of a subsequent prosecution; neither can it appear, that the facts given in evidence against a defendant, on such a general accusation, are the same of which the indictors have accused him; nor can it judiciously appear to the court what punishment is proper for an offence so loosely expressed.

No indictment can be good, without expressly showing some place wherein the offence was committed, which must appear to have been within the jurisdiction of the court.

There are several emphatical words of

art, which the law has appropriated for the description of an offence which no circumlocution will supply; as feloniously, in the indictment of any felony; burglariously, in an indictment of burglary, and the like. And an indictment on the black act for shooting at any person, must charge that the offence was done wilfully and maliciously.

By 10 and 11 William, c. 23, it is enacted, that no clerk of assize, clerk of the peace, or other person, shall take any money of any person bound over to give evidence against a traitor or felon, for the discharge of his recognizance, nor take more than two shillings for drawing any bill of indictment against any such felon, on pain of five pounds to the party grieved, with full costs. And if he shall draw a defective bill, he shall draw a new one gratis, on the like penalty. With respect to drawing indictments for other misdemeanors, not being treason or felony, no fee is limited by the statute, the same therefore depends on the custom and ancient usage.

Every person charged with any felony or other crime, who shall on his trial be acquitted, or against whom no indictment shall be found by the grand jury, or who shall be discharged by proclamation for want of prosecution, shall be immediately set at large in open court, without payment of any fee to the sheriff or gaoler; but in lieu thereof, the treasurer, on a certificate signed by one of the judges or justices, before whom such prisoner shall have been discharged, shall pay out of the general rate of the county or district, such sum as has been usually paid, not exceeding thirteen shillings and fourpence.

By these words, immediatly set at large, the reader must not understand that this actually takes place immediately after the throwing out of the bill. It is usually done after the assizes or sessions are over, and when the judge or justices proceed to the gaol-delivery, as it is called. This affords an opportunity for the preferring a new indictment against the party, if there should be occasion; and it is upon this ground, that the detention of a prisoner, after rejecting the indictment by the grand jury, is countenanced. It is, however, in many cases, a hardship. The present sheriffs of London, in A. D. 1808, Sir Richard Phillips, Knt., and Mr. Alderman Smith, have, very much to their credit, endeavoured to procure the judges at the Old Bailey to discharge prisoners immediately, but the practice having long continued as above stated, the judges have been averse to altering it.

Upon a certificate of an indictment being found, for an assault or other misdemeanor, and much more for a felony, at the sessions, a warrant is issued, on the application of the prosecutor, to take the party into custody, and he may be held to bail by a justice of the peace, or a judge, and it is usual, in expectation of such a warrant, to put in bail, and obtain a supersedeas to the warrant previously. This was not formerly the practice, upon indictments or informations in the court of King's Bench. An act has now passed to enable the court to issue warrants, and hold to bail, upon indictments or informations filed. This act is principally objectionable, as it may be used as the means of harassing persons, prosecuted harshly and vindictively by the Attorney General, for libels, &c. It is either a useless act, since the justice of the country has been safely conducted for centuries without it, or it is an act of great importance to the liberty of the subject.

But an action cannot be brought by the person acquitted, against the prosecutor of the indictment, without obtaining a copy of the record of his indictment and acquittal; which, in prosecutions for felony, it is not usual to grant, if there be the least probable cause to found such prosecution upon; for it would be a very great discouragement to the public justice of the kingdom, if prosecutors who had a tolerable ground of suspicion, were liable to be sued at law whenever their indictments miscarried. But an action on the case, for a malicious prosecution, may be founded on such an indictment whereon no acquittal can be, as, if it be rejected by the grand jury, or be coram non judice, or be insufficiently drawn; for it is not the danger of the plaintiff, but the scandal, vexation, and expence, upon which this action is founded. However, any probable cause for preferring it, is sufficient to justify the defendant, provided it do not appear, that the prosecution was malicious. And it is necessary to show something more than the mere not prosecutis, in order to raise the inference of malice.

INDIGESTION. See Medicine.

INDIGO, a dye prepared from the leaves and small branches of the *indigofera tinctoria*. See the next article.

Indigo is distinguished into two kinds, the true and the bastard. Though the first is sold at a higher price on account of its su-

periority, it is usually advantageous to cultivate the other, because it is heavier. The first will grow in many different soils; the second succeeds best in those which are most exposed to the rain. Both are liable to great accidents. Sometimes the plant becomes dry, and is destroyed by an insect frequently found on it; at other times, the leaves, which are the valuable part of the plant, are devoured in the space of twenty-four hours by caterpillars. This last misfortune, which is but too common, has given occasion to the saying, "that the planters of indigo go to bed rich, and rise in the morning totally ruined." This production ought to be gathered in with great precaution, for fear of making the farina that lies on the leaves, and is very valuable, fall off by shaking it. When gathered, it is thrown into the steeping-vat, which is a large tub filled with water. Here it undergoes a fermentation, which in twenty-four hours at furthest is completed. A cock is then turned to let the water run into the second tub, called the mortar or pounding tub. The steeping-vat is then cleaned out, that fresh plants may be thrown in; and thus the work is continued without interruption. The water which has run into the pounding-tub is found impregnated with a very subtle earth, which alone constitutes the dregs or blue substance that is the object of this process, and which must be separated from the useless salt of the plant, because this makes the dregs swim on the surface. To effect this, the water is forcibly agitated with wooden buckets that are full of holes and fixed to a long handle. This part of the process requires the greatest precautions. If the agitation be discontinued too soon, the part that is used in dying, not being sufficiently separated from the salt, would be lost. If, on the other hand, the dye were to be agitated too long after the complete separation, the parts would be brought together again, and form a new combination; and the salt reacting on the dregs would excite a second fermentation, that would alter the dye, spoil its colour, and make what is called burnt indigo. These accidents are prevented by a close attention to the least alterations that the dye undergoes, and by the precaution which the workmen take to draw out a little of it from time to time in a clean vessel. When they perceive that the coloured particles collect by separating from the rest of the liquor, they leave off shaking the buckets in order to allow time to the blue dregs to precipitate to the bottom of the tub, where they are left to settle till the water is quite clear. Holes made in the tub, at different heights, are then opened one after another, and this useless water is let out. The blue dregs remaining at the bottom having acquired the consistence of a thick muddy liquid, cocks are then opened, which draw it off into the settler. After it is still more cleared of much superfluous water in this third and last tub, it is drained into sacks; from whence, when water no longer filters through the cloth, this matter now becomes of a thicker consistence, and is put into chests, where it entirely loses its moisture. At the end of three months the indigo is fit for sale.

It is used, in washing, to give a bluish colour to linen: painters also employ it in their water-colours; and dyers cannot make fine blue without indigo. The ancients procured it from the East Indies; in modern times it has been transplanted into America. The cultivation of it, successively attempted at different places, appears to be fixed at Carolina, St. Domingo, and Mexico. That which is known under the name of Guatimala indigo, from whence it comes, is the most perfect of all.

Indigo may be obtained from the merium tinctorium, and the isatis tinctoria or woad; a plant cultivated and even found wild in England. When arrived at maturity, this plant is cut down, washed, dried hastily in the sun, ground in a mill, placed in heaps, and allowed to ferment for a fortnight. It is then well mixed, and made up into balls, which are piled upon each other, and exposed to the wind and sun. In this state they become hot, and exhale a putrid ammoniacal smell. The fermentation is promoted, if necessary, by sprinkling the balls with water. When it has continued for a sufficient time, the woad is allowed to fall to a coarse powder; in which state it is sold as a dye-stuff. By treating woad nearly in the same manner with the indigofera, indigo has been obtained from it by different chemists.

Indigo is a soft powder, of a deep blue, without either taste or smell. It undergoes no change, though kept exposed to the air. Water, unless kept long upon it, does not dissolve any part of it, nor produce any change. When heat is applied to indigo, it emits a bluish red smoke, and at last burns away with a very faint white flame, leaving behind it the earthy parts in the state of ashes. Neither oxygen nor the simple com-

bustibles have any effect upon indigo, except it is in a state of solution; and the same remark applies to the metallic bodies. The fixed alkaline solutions have no action on indigo, except it is newly precipitated from a state of solution. In that case they dissolve it with facility. The solution has at first a green colour, which gradually disappears, and the natural colour of the indigo cannot be again restored. Hence we see that the alkalies, when concentrated, decompose indigo. Pure liquid ammonia acts in the same way. Even carbonate of ammonia dissolves precipitated indigo, and destroys its colour; but the fixed alkaline carbonates have no such effect. Lime-water has scarcely any effect upon indigo in its usual state; but it readily dissolves precipitated indigo. The solution is at first green, but becomes gradually yellow. When the solution is exposed to the air, a slight green colour returns, as happens to the solution of indigo in ammonia; but it soon disappears.

The action of the acids upon indigo has been examined with most attention, it certainly exhibits the most important phenomena. When diluted, sulphuric acid is digested over indigo, it produces no effect, except that of dissolving the impurities; but concentrated sulphuric acid dissolves it readily. One part of indigo, when mixed with eight parts of sulphuric acid, evolves heat, and is dissolved in about twenty-four hours. According to Haussman, some sulphurous acid and hydrogen gas are evolved during the solution. If so, we are to ascribe them to the mucilage and resin which are doubtless destroyed by the action of the concentrated acid.

The solution of indigo is well known in this country by the name of liquid blue, or sulphate of indigo. While concentrated it is opaque and black; but when diluted it assumes a fine deep blue colour; and its intensity is such, that a single drop of the concentrated sulphate is sufficient to give a blue colour to many pounds of water. Bergman ascertained the effect of different reagents on this solution with great precision. Dropt into sulphurous acid, the colour was at first blue, then green, and very speedily destroyed. In vinegar it becomes green, and in a few weeks the colour disappears. In weak potash it becomes green, and then colourless. In weak carbonate of potash, there are the same changes, but more slowly. In ammonia and its carbonate, the colour becomes green, and then disappears. In a solution of sugar, it became green, and at last yellowish. In sulphate of iron, the colour became green, and in three weeks disappeared. In the sulphurets the colour was destroyed in a few hours. Realgar, white oxide of arsenic, and orpiment, produced no change. Black oxide of manganese destroyed the colour completely. From these and many other experiments it was inferred, that all those substances which have a very strong affinity for oxygen give a green colour to indigo, and at last destroy it. Hence it is imagined, that indigo becomes green by giving out oxygen. Of course it owes its blue colour to that principle.

INDIGOFERA, *Indigo* or *Indicum*, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx spreading; keel of the corolla, with an awl-shaped spreading spur on each side; legume linear. There are thirty-five species. The indigo's are shrubs, under shrubs, or herbs; the leaves are in some few cases simple, in more ternate, in most unequally pinnate; the leaflets in some jointed and awned at the base, as in phaseolus; stipules distinct from the petiole; peduncles axillary, one or two-flowered, in spikes or racemes. The herb in most of the species yields a blue dye, which is not peculiar to this genus, many plants of this natural class abounding with the blue colouring matter.

INDIVIDUAL, in logic, a particular being of any species, or that which cannot be divided into two or more beings equal or alike.

The usual division in logic is made into genera, those genera into species, and those species into individuals.

INDIVISIBLE, among metaphysicians. A thing is said to be indivisible absolute, absolutely indivisible, that is a simple being, and consists of no parts into which it may be divided. Thus God is indivisible in all respects, as is also the human mind, not having extension or other properties of body.

INDIVISIBLES, in geometry, the elements or principles into which any body or figure may be ultimately resolved; which elements are supposed infinitely small: thus a line may be said to consist of points, a surface of parallel lines, and a solid of parallel and similar surfaces; and then, because each of these elements is supposed indivisible, if in any figure a line be drawn through the ele-

ments perpendicularly, the number of points in that line will be the same as the number of the elements; whence we may see that a parallelogram, prism, or cylinder, is resolvable into elements or indivisibles, all equal to each other, parallel and like to the base; a triangle into lines parallel to the base, but decreasing in arithmetical proportion, and so are the circles which constitute the parabolic conoid, and those which constitute, the plane of a circle, or surface of an isosceles-cone. See INFINITESIMALS.

A cylinder may be resolved into cylindrical curve surfaces, having all the same height, and continually decreasing inwards, as the circles of the base do on which they insist.

The method of indivisibles is only the ancient method of exhaustions, a little disguised and contracted. It is found of great use in shortening mathematical demonstrations, of which take the following instance in the famous proposition of Archimedes, *viz.* that a sphere is two thirds of a cylinder circumscribing it.

Suppose a cylinder, an hemisphere, and anin verted cone (Plate Miscel. VI. fig. 13.), to have the same base and altitude, and to be cut by infinite planes all parallel to the base, of which dg is one. It is plain the square of dh will be every where equal to the square of kc (the radius of the sphere) the square $hc = eh$ square; and consequently, since circles are to one another as the squares of the radii, all the circles of the hemisphere will be equal to all those of the cylinder, deducting thence all those of the cone: wherefore the cylinder, deducting the cone, is equal to the hemisphere: but it is known that the cone is one-third of the cylinder, and consequently the sphere must be two-thirds of it. Q. E. D.

INDORSEMENT, in law, signifies any thing written upon the back of a deed or other instrument. On sealing of a bond the condition of the bond may be indorsed, and then the bond and indorsement shall both stand together. In order to the executing a justice of the peace's warrant in another county, it must be indorsed by some justice in such other county, which is commonly called backing the warrant. It it customary also to indorse the receipt of the consideration-money upon a deed; or an assignment of a lease may sometimes be made by indorsement. Indorsement, is also that act by which the holder of a bill of exchange, or promissory note, payable to order, transfers such instrument, and his interest, therein, to some other person, who is then termed the indorsee, and who, by such transfer and assignment renders himself responsible for presenting such instrument, and using all due diligence to obtain payment of the acceptor or maker.

INDUCTION is the giving a clerk instituted to a benefice, the actual possession of the temporalities belonging to it, in the nature of livery of seisin. It is performed by a mandate from the bishop to the archdeacon, who commonly issues out a precept to some other clergyman to perform it for him; which being done, the clergyman who inducts him indorses a certificate of his induction on the archdeacon's mandate, and they who were present testify the fact under their hands. And by this the person inducted is in full and complete possession of all the temporalities of his church.

INEBRIANTS, a term derived from the Latin, and applied to that class of substances that affect the nerves in a particular and agreeable manner, and through them alter and disturb the functions of the mind. They are divided into natural and artificial: the former are chiefly in use among oriental nations; to the latter Europeans have recourse. Natural inebriants are opium, in use in Turkey and the East; peganum harmala, Sirian rue; of this the seeds are chiefly used: maslac of the Turks, or bangue of the Persians, prepared from the dust of the male flower of hemp; bangue of the Indians, from the leaves of the hibiscus abelmoschus; seeds of various species of the datura, or thorny apple; penang, or betel, of the Indians; roots of black henbane; hyoscyamus physaloides; berries of the night shade; leaves of millefoil; tobacco. Artificial inebriants are fermented liquors from farinaceous seeds; wines and spirits drawn by distillation. See DRUNKENNESS.

INERTIA *of matter*, in philosophy, is defined by Sir Isaac Newton to be a passive principle by which bodies persist in a state of motion or rest, receive motion in proportion to the force impressing it, and resist as much as they are resisted. It is also defined by the same author to be a power implanted in all matter, whereby it resists any change endeavoured to be made in its state. See MECHANICS.

All bodies persevere or continue, as of themselves, in their state of rest or of uniform motion in a right line, in such manner, that a body at rest cannot move without being solicited or urged by some force;

neither can the rectilinear and uniform motion of a body be changed without the action of a foreign cause. That want of aptitude which bodies have, of producing in themselves a change in their actual state, is called inertia. Now it is known that a body, whose state may be changed by the action of a foreign force, cannot give way to that effect, otherwise than by itself altering the state of that force; that is to say, by itself taking away a part of its motion. It has hence been concluded, that the continuance of a body in its state of repose, or of uniform motion, was itself the effect of a real force which resided in that body; and this force has been viewed, sometimes as a resistance in so far as it opposed itself to the action of the other force, which changed the state of that body, and sometimes as an effort, inso far as it tended to carry with it the change in the state of the other force.

The celebrated Laplace has proposed a more precise and natural manner of contemplating inertia. To conceive in what it consists, suppose a body in motion to meet with a body at rest: it will communicate to it a part of its motion; in such manner, that if the first have, for example, a mass double to that of the second, in which case its mass will be two-thirds of the sum of the masses, the velocity which it will retain will be also two-thirds of that which it had at first; and as the other third which it has yielded to the second body employs itself upon a mass of only half the magnitude of the former, the two bodies will both have the same velocity after the shock.

The effect of inertia is reduced, therefore, to the communication made by one of these bodies to the other, of a part of its motion; and since this latter cannot receive, but in consequence of the other's losing, this loss has been attributed to a resistance exercised by the body receiving the motion. But in the instance before us, it is very nearly as in the motion of an elastic fluid, contained in a vessel from which we would open a communication to another vessel which should be empty; this fluid would introduce itself by its expansive force into the second vessel, until it became uniformly distributed in the capacities of the two vessels: in like manner a body when it strikes another does nothing else, if we may so express ourselves, than pour into this latter a part of its motion; and there is no more reason to suppose a resistance in this case than in the examples we have just cited. It is true that when we strike with the hand a body at rest, or whose motion is less rapid than that of the hand, we imagine that we experience a resistance; but the illusion proceeds from this, that the effect is the same with regard to the hand, as though it were at rest, and was struck by the body with a motion in a contrary direction.

INFAMY, in law, which extends to forgery, perjury, gross cheats, &c. disables a man to be a witness or a juror; but a pardon of crimes restores a person's credit, to make him a good evidence.

INFANCY, the first stage of life. In a medical and political view, extending from birth to about the seventh year. Like every other stage of life, it is subject to its peculiar diseases, even in the healthiest state of the constitution, and under the best and most natural controul. But from a too generally inherent debility produced by the common consequences of polished and fashionable life, added either to maternal neglect, or a superabundance of maternal assiduity and anxiety, it is also exposed to diseases of great variety and violence from which it would otherwise be exempt.

The natural infirmity of infant life exposes it at all times, and in all situations, to a mortality far exceeding that of any other stage: but from the powerful effect of such accessary causes, in conjunction with the impure air of crowded towns and cities, we are often called upon to contemplate this mortality, trebled or quadrupled beyond its appropriate ratio; and to behold more than half the natives of a place die within the narrow term of the first three years of life, instead of the greater part of them reaching the age of twenty-five or thirty, and, of course, living to become husbands and wives, and giving birth to generations which are thus cut off along with themselves.

What then are the best means of diminishing this melancholy and sweeping mortality? There cannot be a more important question either in medicine or in politics. To offer all that is worthy of notice in the latter view, would be to engage in a much longer and a more speculative discussion than the limits of the present article, or even of the present work, would allow. We shall confine ourselves, therefore, in what we shall have further to advance upon the subject to the point of medical and domestic attention alone; and shall beg leave,

upon this restricted scale, to propose such hints as may have a tendency to remove a considerable part of the evils of which we complain. In doing this, we shall first notice what ought to be the treatment of infants in a state of health, and secondly in a state of disease.

Treatment of Infants in Health.

The two primary objects of attention on the birth of an infant are warmth and cleanliness. The last has lately been opposed, but certainly without due consideration. The limbs and body of an infant when first born are generally covered over with a mealy mucus matter, which appears to be a feculent deposit from the amnios, or fluid, in which he was immersed antecedently to his birth. "This coating, or covering," we are told, "which the infant obtains in the womb, is surely not put there for nothing. Be assured, that nature has some wise and necessary design, or purpose, in the matter; for it adheres, and it adheres most firmly, to his skin; and, if left to itself, in a certain period after birth it dries, and forms a crust, and gradually scales off in the œconomy of nature, and leaves the skin it covered *heal* and healthful, and capable to bear every common or necessary freedom."

The natural indolence of nurses will be much obliged to this writer, who has acquired, and for various reasons deservedly acquired, considerable popularity, for this novel and extraordinary advice; an advice, than which nothing can be much more pernicious, and which we feel ourselves, therefore, compelled to combat by a few cursory remarks.

This coating, we are told, is not placed over the skin for nothing; and we are desired to rest assured, that nature has some wise and necessary design or purpose in the matter. But what is this wise and necessary design? If not put over the skin for nothing, for what is it put there? These are important questions; but there is not a single hint in the writer's entire book that may serve as an answer to them. We believe, however, and have much reason to believe, that it is put there for nothing; that the deposit of this mucous coating is a mere accident, resulting from a casual change in the state or proportion of the amnios; and not designed by nature to answer any necessary purpose whatever. If nature really designed any useful purpose by such a deposit, we should find her producing it uniformly in the same quantity and quality. But while many infants are born without any such deposit whatever, the covering that surrounds others differs materially, both in its nature and proportion, sometimes being diffused over the whole body, at others confined to particular parts of it; sometimes being a white, thick, pultaceous mass, derived alone from the amnios, and at others a pitchy tenacious fluid, chiefly derived from a discharge of meconium. Yet be it what it may, we are told that our nurses "have nothing to do but to take the infant's skin as nature gives it them: nothing to do but to dry it in the most kind and gentle manner, with the receiver, or a piece of old soft spongy cloth, warmed at the fire, and then proceed to clothe him." Yet if they have nothing to do but to take the skin as nature gives it them, they ought not to dry it, for nature gives the skin to them moist; they ought not to clothe it, for nature gives it to them without covering; and the young of many other animals, though wholly unfurnished with ready-made dresses against their birth, are born just as naked and unfledged as the human infant. Above all, they ought not to clean it, either with the receiver, or a piece of old spongy cloth; or this is to destroy the very foundation of the author's new system, which consists in its not being cleaned by any means, not even by "soap and water, or plain water, or any other substance whatever." Now certainly, if the body of an infant may be rubbed with the receiver, which is usually flannel, or even with a piece of old cloth, there is no reason why he may not be rubbed with a little warm water, which has a far nearer approach to the nature of his prenascent element, than either of these substances, and is far less rough and uncomfortable to its tender and delicate skin.

We shall only offer another remark. Though the author be not able to tell us what good purpose nature designs by diffusing over the body a coating of mealy or viscid mucus, we can easily point out to him what bad purpose nature herself would accomplish by our suffering it to remain there after birth: and we will do it in his own words. "If left to itself, says he, at a certain period after birth it dries, and forms a crust and gradually scales off." And it is for this very reason it ought to be removed: a dry crust and scurf covering the hard and thickened skin even of an adult must necessarily be productive of the double mischief of excoriating the cuticle, and obstructing the matter of perspiration:

how much more then must this double mischief be augmented, when applied to the soft and tender cuticle of an infant: how extensively must its delicate skin become inflamed by such harsh and perpetual pressure; how continually exposed to cutaneous eruptions, from the acrimonious humour into which its obstructed matter of perspiration will be converted by this very obstruction itself.

Let us close by observing that wherever this kind of tenacious covering is found as it sometimes is, spread in an unusual quantity, over the bodies of other animals, the mother of the young commonly removes it by washing and wiping it away with her own tongue and saliva, or by encouraging the new born animal to roll itself on the grass or straw, or whatever other substance may be the bed that first receives it: thus teaching to mankind a lesson of cleanliness, which instead of despising, they will do well to follow. Cleanliness, indeed, from the commencement of life to its termination, may truly be said to be next to godliness; its influence upon the mind is equal to that upon the body. The pleasurable sensation it excites is of no ordinary character; it is a powerful prophylactic against disease; it exhilarates the animal spirits, and gives a feeling of moral dignity to the meanest and most indigent. A habit of cleanliness cannot be commenced too soon, nor persevered in too punctiliously.

The next point to be attended to in the treatment of infants, is that of lactation or suckling.

There is generally to much eagerness in putting the child to the breast; who is often worried to suck before he becomes actuated by the instinctive principle of nature, or before the mother finds her breasts sufficiently filled with milk to satisfy his desire. In consequence of which the mother is as much and as vainly fatigued as the infant, passes a restless night, and is harassed with a renewal of after-pains from which she would otherwise have escaped.

It is generally about the third day, after child-bed, that both are fully prepared; though it sometimes happens that the infant has a desire to suck and the mother to suckle within twenty-four hours from the time of delivery. While again the same mutual propensity will not in other cases occur till a week or a fortnight, or even longer from the same period. In the latter case the infant should be supported by dilute gruel, a dilute solution of tops and bottoms, with or without a little cow's milk, according as he seems best to relish it; and if he appear in good health, no idea should be entertained of providing a wet nurse, till time has fully demonstrated that the mother will be incapable of supporting him herself.

This maternal support is a duty so imperative, that it should only be relinquished under the following circumstances: 1. Suppression of milk. 2. Extreme delicacy, or disease of constitution, by which it may not be supplied in proper quantity or quality. 3. The indulgence in such a routine of fashionable amusements as may render the mother incapable of fulfilling her task with punctuality and satisfaction to her child.

This last conduct is unpardonable, but it is nevertheless common, and we are afraid will be so in the present day, notwithstanding all that can be urged to the contrary, whether by divines or physicians; and all that we attempt to do is to guard against the mischievous effects of such a conduct: for if in this respect the mother remains deaf to the voice of nature, and the languishing desire of her own offspring, we are fully convinced that all we, or any other body of physiologists could urge would be in vain; neither would she be persuaded though one rose from the dead. We will just observe, however, that the practise of repelling milk from a full breast is at times dangerous, and often accompanied with abscesses, that are more inconvenient, last longer in the cure, and are succeeded by far more injury to the polish and harmony of the form than the suckling a large family.

Let us add another reason, the human body is so constituted that one part assists another in the operations of nature: consequently there is a necessity for reciprocal action and rest. Whilst the womb, lately in a state of distention for many months, is thus allowed rest sufficient, it recovers its former tone. Whereas, when there is an annual repetition of pregnancy, the parts so distended, sooner lose their elasticity, and become at length, perhaps, diseased, which especially happens in cases where the original habit has been weakly.

The following is a reason that concerns the public, whatever influence it may have on the gay and the careless. The hired nurse, anxious to save as much as possible from her own wages, not only weans her own child, but puts him at board on the

cheapest terms she can find; in consequence of which, innutrition, or poverty of food, too generally terminates his life, or leaves him habitually diseased, a permanent burden on his parents, and on the public.

Hireling nurses, however, under all the cases we have mentioned must be resorted to, when the person is in a situation to endure the expence. The young and the healthy should be selected with a full breast of milk, and that milk as nearly as may be of the age of the foster child. Where the circumstances of the parents, or the infant's own antipathy, which sometimes occurs, or any other equally insurmountable objection intervenes, the next consideration is to provide a subsitute for the child's natural diet.

From the experiments of physicians on milks we have the following results.

Of cream, the milk of sheep affords most; then the human, the goat's, the cow's, the ass's and the mare's progressively.

Of butter, the sheep's affords most, then the goat's, the cow's, and human progressively.

Of cheese, the sheep's gives most; then the goat's, the cow's, the ass, and human milk, the mare's gives the least.

Of sugar, most is extracted from the mare's milk; then from the human, the ass's, the goat's, the sheep's, and last of all, the cow's.

It should hence seem that human milk has more saccharine matter than any other milk excepting mare's; more cream than any other excepting sheep's, and at the same time that it yields less butter or cheese than any excepting mare's. It appears, moreover, from the experiments of other animal chemists, that the butter of human milk, instead of being solid like that of the goat and cow, is a fluid of the subsistence of cream, and cream which is nearly the consistency of that obtained from ass's and mare's milk.

It follows, that, upon the whole, mare's and ass's milks have a nearer resemblance to human, than the milk of any other animal that has undergone a proper course of experiments: and that in case of extreme debility of the organs of digestion mare's or ass's milk is the best substitute for that of human milk.

Let these therefore in cases of debility be resorted to: but in cases of health, and especially of good substantive organs we may be less particular. Diluted cow's milk, intermixed with a small quantity of farinaceous food will generally prove the most convenient nutriment. Cow's milk, however, is far less sweet, or has far less saccharine matter than human, and hence the mixture now recommended should be enriched with some addition of sugar. The chief point of attention is that the farinaceous matter, whether in the form of pap or gruel, be sufficiently dilute, and free from lumps. It is a difficult thing to make nurses believe that fluid food alone can produce solid nutriment notwithstanding the example daily before them of the beneficial result of maternal milk; and hence it is almost impossible to prevent them from making the infant food too thick and pulpy. Where fusks, or tops and bottoms, are used they should be first boiled in water till perfectly softened, and then pressed with a spoon through a fine strainer; nor should pap or gruel be ever made use of without a similar process. Cordials, aperients, and opiates should be equally avoided in a state of health. They are all medicines, and should never be employed but when called for by disease; nature, in her ordinary functions, demands nothing of the kind: the food prepared by herself is equally bland and simple.

In the clothing of children, warmth and simplicity are the two points to be studied. The great and natural use of clothes is for the purpose of warmth, and the looser and softer the substance is by which this warmth is communicated, the better. But, amongst other refinements, that of giving neatness to the attire of children has been one productive of very great evils. To brace and dress an infant forms a particular business, and thus the real intention of clothing has been lost sight of. Besides their tightness, children are also often hurt by their quantity. After birth, a child is in a sort of feverish state during the first five or six days; it should, therefore, be kept cool, instead of being laid close to the mother, who is commonly in the same state, and fed, as both too frequently are, with heating cordials, which add to their uneasiness.

Most of the deformities of children are occasioned by improprieties in their dress. An attempt to give neatness to the form renders pressure necessary; and where a part is weak, and the pressure greater than on the neighbouring parts, such part will naturally yield to the impulse, and deformity will ensue. Without entering therefore into any criticism on the particular kinds of dress, all that is required is, that

child be kept warm, and the dress sit y on every part.

Sleep is at all times necessary to health; in infancy it is particularly so; for the stimuli of air and light alone are sufficient to exhaust the system in an hour or two. Yet order is one of the first laws of nature; and habit is its best foundation. After the first few days, therefore, of mere introduction to a new world, and a new mode of existence, the periods of sleep should submit to some degree of regulation. An infant that is allowed to sleep through nearly the whole of the day, will usually be a very troublesome companion to its mother through the whole of the night. It has had more than a sufficiency of rest, and cannot be made to sleep, till it again becomes tired and exhausted. Then comes the nurse, with her nostrums and her lullabies; her cradle, her cordials, and her anodynes. The whole are useless in a state of health, and many of them most pernicious. The fault is all her own; it proceeds alone from a want of regular periods of sleep and wakefulness.

The situation of children requires at first air of a moderately warm temperature; after which they may be gradually inured to a colder atmosphere, without any danger to their health. Too much warmth, however, is as prejudicial as the opposite extreme, and the more to be dreaded, as every time they are brought to the open air, they are exposed to the danger of catching cold. But it is not merely a cold air that is to be avoided, it is air that is confined, and at the same time loaded with moisture. A confined damp air is the cause of many of the diseases by which children are afflicted; and to this state of the atmosphere the children of the poorer classes are particularly exposed. Too much caution cannot be used by parents in superintending this part of the treatment of their offspring. When sent abroad, under the care of servants, they are often kept too long exposed to the inclemencies of the weather, and frequently allowed to sit or lie on the damp ground; or they are kept carelessly in the arms of a servant, exposed to a current of air, the consequence of which, when brought from the confinement of a warm room, must be mischievous. To avoid the danger of cold, then, much attention should be paid to the dress, and not to allow the period of their exposure to be too long at a time. They should, however, be carried out at least once a day, when the weather permits, and that generally about mid-day, and, if possible, into fields, or squares, or other exposed situations.

The same caution that is necessary in carrying them out, should be applied to the conduct within doors. The nursery should be the largest and best aired room in the house. When children sleep in a cradle, they should not be wrapped up too closely, particularly so, as they are usually laid in with their clothes on. Neither when they are further grown, should more than one child sleep in the same bed. In short, the proper regulation is, to keep the child as much as possible in one pure, equal temperature, avoiding every thing that is damp and unwholesome; and, if this equality of atmosphere cannot be preserved in our own country, to take care, at least, that the transitions from heat to cold be not made too suddenly; by which attention, all the evils arising from this source will be avoided.

Exercise is natural to man, and the desire of it is coeval with existence; nay, may be said to precede it; for the motions of the child in the womb show, that it is with difficulty retained in a passive state. Infants, therefore, ought never to be at rest but when asleep, and this motion is of the first importance; it will atone for several defects in nursing, and is absolutely necessary for the health, strength, and growth of children.

The first exercise that children usually receive, and which they ought to receive, is that of being dandled in the arm, or moved gently up and down, which tends much to assist digestion. Rubbing them with the hand is also highly useful at this period of life, particularly along the back-bone, which occasions the child to stretch itself, and to exhibit different signs of muscular exertion, expressive of the satisfaction it receives.

As children increase in growth, their exercise should be proportionably augmented, and the nurse should endeavour to give them as much motion with her arm as possible. A proper nurse knows the method of doing this, and requires no specific directions.

As soon as a child is able to be put on its feet, it should be allowed to make use of them. Every member acquires strength in proportion as it is exercised; and children, by being accustomed to support themselves, will soon acquire strength for the purpose. Children also begin to use their feet by degrees, and by this gradual attempt, all the dangers hinted at by

writers, of their legs becoming crooked, or unable to support the body, are avoided.

Among the poorer classes, it is very common to allow children to sit or lie in one posture for a length of time: this is a practice much to be condemned. By the want of exercise, the health of children suffers; a relaxation of the system ensues, and rickets and other diseases are induced. The constitution of man evidently shows him at all times designed for exercise, and the regular circulation of the fluids cannot proceed without its assistance. Arguments, indeed, may be drawn from the structure of every part of the animal economy of man; and, where exercise is neglected, none of the animal functions can be duly executed, and the constitution, in general, therefore must soon be seriously affected.

The early and rigorous confinement of children at day-schools, merits to be particularly reprobated. To prevent trouble to the parent, the infant is often sent to school, perhaps for seven or eight hours on a stretch, at a period of life when it can learn little or nothing, and when its time would be more properly spent in exercises or diversions. Nor does the mind suffer less from this evil than the body. The fixing it to one object so prematurely, provided it can really be made to learn any thing at all, not only weakens the faculties, but is apt to produce an aversion, on the part of the child, to study at that time of life when study would be useful. Even the immuring such a number of children in a confined room, as we often meet with in little day-schools, by vitiating the atmosphere, and corrupting the air, must lay the seeds of disease, and not unfrequently occasion infection. If sent early to school, the time of learning should never be long, and should be alternated with proper diversions and exercises suited to their period of life.

The only argument in favour of an early education is the advantage of an early entrance of children into the world; and of their being able to provide for themselves. That this may be proper in one respect, and in certain classes of society, we shall readily admit; but if the constitution be to be ruined at an early period, twice as much will be lost as gained by this deceitful system. The truth of such a remark is strongly confirmed by what we every day observe in manufacturing towns, where life is seldom protracted beyond its middle age, and little enjoyed, even if it should be, from the sickly constitution entailed on its possessor by this early industry.

Even exercise within doors is not sufficient to effect the good purposes derived from it in the open air, particularly in a country situation, where the various exhalations and fragrances of the surrounding scenery, add usually to the salubrity of the employment. Children, instead of being checked in regard of wholesome play, should be at all times encouraged in it. This advice is particularly necessary in respect to girls, who are, in general, too much confined by their injudicious mothers, and thus are not only weak and debilitated in their general habit, but acquire most of those diseases peculiar to their sex. No injury can take place from suffering them to run about, without unnecessary restraint. Dancing, if not carried to excess, is of excellent service to young persons; it cheers the spirits, promotes perspiration, strengthens the limbs, and at the same time gives a much better grace to the person, than a constant employment at needle-work, or even an acquisition of the general and various accomplishments that constitute modern female educations; which, however, would by no means be impeded by giving scope to exercise.

A popular writer well observes, that "an effeminate education will infallibly spoil the best constitution, and if boys are brought up in a more delicate manner than even girls ought to be, they will never be men." The same author, with great justice, applauds the practice, of late introduced, of teaching boys the military exercise, as not only an admirable mean of strengthening their body and limbs, but of inspiring them with early ideas of courage, and educating them so that they may, at a future period, be ready and able to defend their country in case of emergency.

To uniform exercise, add the use of the cold bath: it will prove an admirable auxiliary, and may be even a substitute for exercise where it cannot be duly obtained; and if the salt-water bath can be had, it is certainly preferable. By general immersion, the body is braced and strengthened, the general circulation increased, and all stagnation in the smaller vessels prevented. The commencement of this practice, early, will be the means of preventing the appearance of many constitutional diseases. It cannot be too much inculcated, and has been in use from time immemorial with

those nations who have been most distinguished for the enjoyment of health and vigour of constitution. No prejudices, therefore, of the mother or nurse, should prevent the use of this salutary prophylactic; and even where it cannot be employed to its full extent, still the extremities should be every day bathed in cold water, and afterwards well dried, and the skin well rubbed. In this view, boys, instead of being prevented by their fond and fearful mothers, should, on every account, be encouraged to learn and practise the salubrious and useful exercise of swimming.

Diseases of Infants.

The diseases of infantile life are very numerous, and some of them very complicated. It would be absurd to attempt a discussion of the whole of these within the limits of a narrow, and what is merely designed as a popular essay. We shall confine ourselves, therefore, to those alone, which are more common or more manageable, and a general knowledge of the nature of which, may enable the mother to co-operate with the intention of the medical practitioner whom she may find it expedient to consult. These we shall arrange under the heads syncope; retention of meconium; jaundice; costiveness; looseness; acidity, and flatulence; thrush; cutaneous eruptions; dentition; convulsions; and rickets. For the rest, we must refer the reader to their regular classification, under the article MEDICINE.

The process of birth is, at times, attended with difficulty and danger, and especially exhaustion to the child, as well as to the mother: and as the latter, upon delivery, experiences occasionally syncope, or fainting, so does the former not unfrequently; its life, when first born, appears feeble and uncertain, and the only proof of animation is derived from the pulsation of the navel-string. Generally the infant soon recovers from this state, and without relapse. But at times the syncope continues for hours; the infant gasps faintly, and then evinces no sensible appearance of respiration, for ten minutes or even longer; occasionally the face is languid and pale, but sometimes suffused with blood: this attack may also repeatedly recur.

The only remedies here are gentle stimulants and cordials. The nostrils and temples, as well as the hands and feet, may be rubbed with a little volatile salt, and as soon as swallowing is practicable, a little wine may be administered, containing a few drops of volatile tincture of valerian. These remedies may be repeated every two or three hours till recovery take place: after which, stools should be obtained by means of a clyster, or a tea-spoonful of castor oil.

The name of meconium is given to the first contents of the bowels of children consisting of a black, pitchy matter, highly tenacious. This usually passes away within a day or two after birth, and if retained beyond this period, proves the source of very troublesome complaints. This substance, it is clear, whatever be its cause or intention, is no longer useful after the child is born, and should be discharged as soon as possible; to which, from its own irritating nature, there is constantly a tendency. But, in certain cases, from the torpor of the bowels, or its own unusually viscid, or clammy state, this discharge is delayed, and irritation, pain, and griping ensue. If the first milk, therefore, do not prove laxative, and bring it away, a tea-spoonful of castor oil should be given once, or oftener, till the bowels be disburdened, and the symptoms of uneasiness entirely cease.

It has been common, indeed, even at birth, antecedently to its discharge, to administer a gentle laxative for this purpose; nor can there be any objection to that practice, however reprobated by some physicians. A little syrup of roses will generally be sufficient; or, in the country, a little fresh whey and honey. Should a stronger laxative be required, then the castor oil may be recommended, or a watery infusion of rhubarb, cannot fail to answer the effect. But should they be slow in producing the ease and freedom from pain, for which they are intended, and no stools have been procured for twelve or fourteen hours after birth, a clyster may be thrown up, and repeated at the distance of a few hours, which will answer every purpose, and the discharge once begun, and the bowels brought into action, the meconium will gradually pass off, for several days, without any further trouble.

Jaundice is a disease to which infants, at birth, are very subject, and may be said to take place always to a certain degree. It is easily known by the tinge of the skin, and more particularly the saffron hue of the eye. The nails, however, are not here coloured, as with adults; but the yellowness of the complexion gradually increases, as in other cases.

This disorder is evidently the effect of a

viscid matter obstructing the gall-ducts; in order to remove which, a gentle emetic is required. That generally preferred, is the tartarised wine of antimony, in the dose of a single drop or two; and it has the advantage of also passing downwards. In giving vomits, however, at this period, there is often much danger, and instead of the tartarised antimony, which is rather uncertain in its operation, three or four grains of ipecacuanha will be safer, which should be followed the next day with the same quantity of rhubarb. Where the symptoms do not seem to yield, the same plan should be continued every other day, till the yellowness begin to disappear, which it generally does in about a week. In this compiaint, the mere opening the bowels does not seem entirely sufficient to remove the colour of the skin. Even at times, along with the former treatment, some addition of saponaceous or soapy medicines becomes necessary, as two or three drops of prepared kali; while, to assist its operation, both the warm bath, and friction of the stomach may be conjoined.

On this subject it may be farther observed, that no tinge is communicated to the child from the mother, though she have been afflicted with the disease during pregnancy; but, at the same time, if it continue with her after delivery, and she suckle her child, the true jaundice will be communicated to the infant, and the disease remain till it be either weaned or the mother recover.

There are few infants, even under the most favourable circumstances of management, that will reach the termination of the first six, or even the first three months, without some morbid affection of the bowels. The diseases of this tribe are chiefly costiveness, looseness, acidity, and flatulence.

Of these the first is not very frequent: it exists nevertheless occasionally, in a very great and even alarming degree; sometimes derived from the constitution of the mother, and sometimes as an idiopathic affection. In the former case we may be always under less apprehension; in the latter case the constipation is occasionally so severe, and accompanied with so much pain, and even spasm, as to threaten an inflammation of the bowels, if not speedily removed. As instantaneous applications, the best remedies are fomentations of hot water, or chamomile decoction, to the belly; doses of calomel, from one to three grains, according to the age of the patient, given by the mouth, and injections of the common enematic decoction, with a little sweet oil, and a solution of neutral salt. This complaint usually proceeds from too rapid an absorption of the more fluid parts of the chyle, by the bibulous mouths of the lacteals, in consequence of which the part that remains is too compact and solid to be forced away by the common peristaltic action. This morbid activity of absorption should be next attended to, to prevent a recurrence of the disease; and occasional doses of rhubarb, alternating with castor oil, is perhaps the best method that can be pursued to obtain this object.

Looseness, or diarrhœa, is, however, a much more common complaint among infants than costiveness. It is often connected with vomiting; and both arise most frequently from one of these three causes; unwholesome food, moist cold air, or the sudden disappearance of some cutaneous eruption. From whichever of these it proceeds, it ought not to be hastily stopped; certainly not till the offensive matter, on which it depends, be totally removed. Where joined with a vomiting, an emetic ought to be the first step, after that the use of rhubarb and absorbents may be ventured on, and continued, with an occasional emetic till the first passages be completely cleared of any irritation which may keep up the disease. If it continue after a sufficient perseverance in this plan, light cordials and opiates should be interposed. If the purging be connected with toothing, or attended with fever, though it continue obstinate, it requires much caution. For, in this case, so far from being a disease, it may, perhaps, be considered itself as a remedy, in preventing the occurrence of more dangerous symptoms. Keeping the discharge merely within bounds is the proper mode of proceeding, and the chalk julep will be the best remedy; when the bowels being once cleared, and the irritation removed, the treatment will be much regulated by the appearance of the stools. These have been distinguished into sour, clayey, watery, bloody, and fetid.

The last kind, when it occurs, requires the use of a powerful purgative, such as senna-tea, if the child be old enough to bear it. Blood is seldom mixed with the stools, but towards the end of the disease, and an occasional streak of it is of little consequence. Watery stools, where combined with greenness, or an appearance of curdled matter, are best removed by a gentle emetic,

and a warm purge. Slimy stools, with an appearance of hiccup, should be treated with magnesia and other absorbents, warmed by the addition of a little grated nutmeg. White and clayey stools are best corrected by a drop or two of the water of kali, mixed with the preceding aperients. A soap clyster will likewise be useful if the complaint be attended with much griping; nor is some light cordial to be withheld; and fomenting the belly with a little warm brandy, or a decoction of camomile-flowers and white poppy-heads, will be a great assistance to the other parts of the treatment.

Wherever purgative medicines are used for children, the form of compounding them is a material circumstance. They should always possess the addition of aromatics, especially those of the carminative kind, as a little ginger, pounded cardamum seeds, dill or aniseed water. The pain is hereby relieved, the healthy action of the mouths of the lacteals renewed, and the morbid irritation of the secernents of the intestines diminished.

Improper food is the common cause of infantile diarrhœas: either an acetous fermentation is excited in the stomach, or the gastric juice is changed in its nature, and secrets an acid of its own. Other derangements of the bowels may proceed from the use of improper diet; but acidity from one or other of these causes is the common effect. The chief proof of acidity is in the green colour of the evacuations; these are at the same time usually accompanied with pain, and watery in their consistence. If the pain be extreme, the legs rigidly drawn up towards the belly, and the ejections small in quantity, but very frequent, and a mere watery discharge, or intermixed with slime or mucus alone, the disease is then called watery gripes. This, however, is a complaint of the lower and larger intestines rather than of the stomach or digestion itself, and of course evinces less proof of acidity, which is peculiarly dependent upon the stomach.

Acidity is also said to be evinced by the regurgitation of curdled milk; but this is not strictly correct. The milk of all animals is curdled, in a state of the most perfect health, before it becomes digested, or rather perhaps during the very process of digestion. We cannot now enter into the question, why this change should be necessary: it is enough to state it to be a fact, and to caution the mother against loading the stomach of her child with aperients or absorbent earths, merely because of such curdled regurgitations. The regurgitation is usually the simple effect of superabundance, and the curdled appearance a proof of healthy digestion. The stimulus of superabundance in infancy, as well as in the other stages of life, frequently excites hiccup; an affection peculiarly useful to infants, as the action hereby produced enables the stomach to discharge its contents both through the mouth and into the duodenum. But if the regurgitated food be not only curdled, but evince an acid smell, and especially if the breath itself betray such a smell independently of regurgitation, we have then a sufficient proof of the existence of acidity in the stomach from one of the two causes now enumerated, and should apply ourselves to remedy it.

The first point is to get rid of the acid, or other irritating matter, that actually exists in the intestinal canal; and the second is to prevent the formation of fresh matter of the same kind. The former intention is best accomplished by aperients; and of all aperients by calomel; either alone, or in conjunction with small doses of rhubarb: the latter by changing the nature of the morbid action of the secernents of the stomach or intestines, and recovering them to their accustomed secretions. This is best produced by gentle stimulants, as dill, aniseed, or cinnamon-water, and especially sal volatile, of which two or three drops may be given at a dose, and which answers the double purpose of a stimulant, and a corrector of acidity. If the former be employed, they should be combined with magnesia, chalk, or other absorbent earths, or the aromatic confection, which is an excellent preparation for this purpose.

The use of opiates, after the removal of the peccant matter, may often prove highly serviceable; but it requires a skill so delicate, and a judgment so practised, to determine the time, and apportion the dose, that we dare not recommend opium in any shape as a domestic medicine: it should be alone administered under the advice of a judicious practitioner.

Flatulence, or wind, is rather a symptom of disease than a disease in itself. It is an attendant upon all the complaints we have just noticed, and as it commenced so it will terminate with them. Yet though a mere symptom, it is often found so troublesome, whatever be the disorder or state of the bowels on which it is dependant, as to require specific attention. And here, in con-

junction with the tribe of cordial stimulants just enumerated, we would strenuously advise the application of warm, stimulating liniments to the belly, which should be rubbed over it with easy, but long repeated friction; for the friction of a warm hand alone is serviceable, and usually affords palpable relief even in a short time. If it do not yield to this plan, injections of a decoction of chamomile flowers with a little ginger, or a few cardamum seeds should conjoin, and be repeated daily. Here also, as in the case of simple acidity, the food should be changed if the child be weaned; and even in extreme cases, if he be not weaned, provided there be sufficient suspicion that the milk of the nurse or mother, how well soever it may stand the test of examination, be the productive cause.

When diarrhœas proceed from a moist unwholesome atmosphere; or from a sudden suppression of any cutaneous eruption; it follows, without further instruction, that the only chance of removing the complaint is, in the first instance, by removing the child into a healthier atmosphere; and in the second, by exciting the skin to a new efflorescence.

Another disorder, and frequently a very serious one, originating from a deranged state of the first passages, is thrush. That it arises hence there can be no doubt, as it has been known to seize every infant in a family, in which mismanagement or a want of attention to them took place, from accidental causes; and to disappear as soon as the proper attention was resumed. It is evidently a disease of debility, connected with a predominant acidity, by the continuance of which the complaint is aggravated. It generally takes place in the first month, but may be entirely avoided under proper treatment.

This complaint first appears in the corners of the lips, spreading over the tongue and cheeks, in the form of little white specks. Increasing in number and size, they run more or less together, according to their malignancy, and compose a thin white crust, which at last extends over the whole inside of the mouth, from the lips to the gullet, and even the stomach itself, and reaches at times through the whole length of the intestines, producing a redness at the fundament. When this crust falls off, it is succeeded by others, often of a darker colour; and the same appearance successively recurs till the disease depart.

It is sometimes preceded by sleepiness for a week or two. It is commonly without fever, which only supervenes in its progress, in the same manner as hectic fever is produced in other cases, from the increasing debility of the system. Care should be taken that the child do not catch cold.

The chief source of this disease seems to be indigestion, from whatever cause it may be produced; and therefore bad milk, unwholesome food, or even weakness of the stomach itself, are sufficient to produce it. These causes evidently give rise to acrimony, which particularly affects the small glands of the membrane lining the stomach and bowels. Hence, on the principle of relaxation of these organs, a tea-spoonful of cold water, taken every morning, has been reckoned a useful preventive; and this joined with a due attention to the excretions will often fully succeed.

The principle of cure in this disease is simple and plain. The state of the bowels is the cause; and this state is, at the same time, attended with a certain degree of acrimony. The first step, therefore, is to open the bowels, where costiveness prevails, by means of any of the laxatives enumerated in the preceding diseases. The antimonial wine has been particularly preferred by some physicians; and then correcting the acrimony by means of any of the testacious or shell powders, or which is better, common magnesia. Where the bowels are already in a loose state, instead of the above practice, as the child is generally weakly, two or three grains of the compound powder of contreyerva may be administered; and, as the disease declines, a little rhubarb should be superadded, which will strengthen the bowels by its astringency, and at the same time correct their acrimony. When the disorder is removed, the child's health will be restored by some tonic or strengthening remedies, as a tea-spoonful of camomile tea, or a few drops of the compound tincture of gentian, well diluted. These medicines should be given two or three times a day, the bowels kept regularly open, and the testacious powder not entirely relinquished, but occasionally administered. Where the disease appears very malignant, instead of the bitters recommended, a decoction of the bark, with the aromatic confection will be preferable.

In the use of absorbents, or testaceous powders, the dose cannot be precisely regulated, but must be increased or diminished according to the effects. Three or four grains may be given, three or four

times in the day; and when these medicines are employed, the diet of the nurse should also claim an attention, and her usual quantity of malt liquor be diminished.

Besides this general treatment of thrush, it has been also common to make applications to the part, in order to hasten the exfoliation or scaling, of the surface. Such applications, however, are highly improper, on the first attack of the disease, or till nature shows an actual disposition or tendency to this separation. By beginning with such applications too early, they only increase the soreness of the surface, and by rudely clearing it of the aphthous matter, give a deceitful appearance of amendment. It is proper, however, that the child's mouth should at all times be kept clean, particularly if much foulness prevail, and there be an appearance of thick sloughs. Of the several preparations that have been used for this purpose, borax has gained a decided preference; and it may be mixed up with sugar, in the proportion of one part of the former to seven of the latter. A small portion of this composition may be put on the child's tongue, which will dissolve and be conveyed to the other parts of the mouth; or it may be made up into a paste with honey, which is a better form. No violent rubbing of the parts affected should ever be allowed to take place; as it will both give unnecessary pain to the child, and extend the duration of the disease, by producing a new growth of the same morbid spots on the surface.

The skin and cuticle of infants is peculiarly delicate and irritable, and the action of the air alone upon them, whenever there is a change in the temperature of the atmosphere, is almost always, and sometimes altogether sufficient to produce efflorescences of some kind or other. Hence it is not to be wondered at that they are subject to a variety of cutaneous eruptions or rashes.

The first eruption that is generally noticeable is the red-gum, or red-gown, as it was formerly called, and perhaps ought to be called still; the strophulus intertinctus of authors. It consists in a papulous efflorescence of small spots, confined to the face and neck; or in some cases extending to the hands and legs, and even the whole body, in the form of large patches. It sometimes appears in small pustules, filled with a limpid, purulent, or yellow liquor; and frequently turns dry and horny, and scales off, without giving any further trouble. Another appearance it assumes, is like small pin heads, of a pearl colour, and not transparent. Yet whatever be its appearance, it is evidently the effect of intestinal acrimony, connected with the delicate state of the skin, and determination of the blood towards it. Hence all that is wanted is an attention to the state of the bowels, and the use of testaceous powders in conjunction with cordials or antimonials; while the child should be kept moderately warm, that the eruption may not be suppressed.

It may be observed here, that the state of the bowels and skin have a sympathetic connection, and the bowels, when disordered, are sensibly relieved by an appearance of eruption on the skin. Hence such eruptions, instead of being suddenly repelled, should rather be encouraged, and even, if disappearing, should be invited to return.

The next variety of rashes or papulous eruptions worthy our attention are those denominated milk-blotches, crusta lactea, or strophulus volaticus, by authors; some of whom, however, contend that the eruptions under these names have a trifling difference from each other. It may be so: but the difference is not worth pointing out at present. It generally occurs in infants of an irritable skin, and appears most commonly on the forehead, and the scalp, extending half-way over the face, in the form of large loose scabs. In the progress of the disorder, these scabs much resemble the small-pox when blackened, and at times continue to disfigure the child for several months. Though at last they assume this dark appearance, they begin as white vesicles, with a watery discharge, and great itching of the affected parts.

In this complaint, very little needs to be done. Where the case, however, is severe, an occasional drain by a blister between the shoulders, or behind the ears, will answer the good purpose of transferring, and consequently abating the irritation and itching. The same effect will attend washing the parts with warm beer and butter, where the discharge is very hot and acrid; and the tar-ointment has been employed with equal benefit in the same view.

The duration of the complaint is generally judged of from the state of the urine; and where this discharge is turbid or fetid, the disorder is seldom of long continuance. It generally ceases when the child has cut a few teeth; should it, however, be obstinate, of which there are a few examples, the Harrowgate, or any other sulphureous water,

natural or artificial, will have a good effect.

This eruption has sometimes been improperly mistaken for the venereal disease; but its spontaneous disappearance is a proof that it has no sort of connection with siphilis of any kind.

The tooth-rash affords several varieties, all of which belong to the strophulus tribe, and rank under the strophulus confertus.

The first we shall enumerate is not altogether peculiar to this period. It much resembles the itch, and is most frequent in its appearance about the face and neck, though not exclusively confined to these parts. It has often, from its appearance, been mistaken for the real itch; but it differs so far, that it is of a most salutary tendency, and even sometimes critical in its nature, as preventing, at this juncture, serious effects to the child.

No particular treatment is necessary, except merely avoiding cold, and keeping the bowels soluble.

The next tooth-rash, at this period, is one that greatly resembles flea-bites, having a depressed point in the middle of the elevated spot. This disorder, in some instances, recurs, uniformly, just before the appearance of a tooth, and when cut disappears. Here, in respect to treatment, the same observation applies as in the former case.

A third species appears in the form of measles, and is often mistaken for them. Some degree of sickness generally precedes its appearance, but there is, at the same time, little or no fever. It usually continues very florid for a few days, and when disappearing, does not dry off like the measles.

The treatment here is very simple. The testaceous powders may be employed, with the addition of a little nitre and compound powder of contreyerva; and as the disease declines, a little rhubarb, or other laxative, may be given for a day or two.

A fourth species of tooth-rash is one which, though appearing like the former, soon spreads into large spots, at first of a bright red, and afterwards of a darker hue, similar to the purple spots that appear in typhous fevers, though this be entirely of a different nature. Some fever generally attends the eruption, followed frequently by small round tumours on the legs, which softening in a few days, seem as if inclining to suppurate, though this never takes place.

Like the former, the treatment is simple; and an attention to the state of the bowels, is the only direction to be given. Should the tumours not easily subside, a decoction or injections of the bark may be found useful.

The next species of teeth-rash somewhat resembles the rash of scarlet fever, and is very rare. It is always preceded by sickness, fever, and a disordered state of the bowels; but these symptoms disappear as soon as the eruption is complete, which shows evidently its critical nature of preventing a train of worse maladies.

Such indeed is the variety in the tooth-rashes of children, that it would be almost endless to enumerate them; a variety arising from differences of constitution and other circumstances with which we are unacquainted. But whenever an eruption appears at this period, the safest plan is to consider it as connected with the effort of toothing. If our judgment be correct, the complaint will decay as soon as the tooth is protruded; and if it be not, its nature will be easily ascertained. By attending to the state of the bowels, as already pointed out, all danger of such eruptions will be avoided; and the more they are treated on the ground of being an effort of the constitution to relieve itself by an increased action towards the surface, the more will the safety of the child be consulted. It is of consequence, therefore, in order to silence the clamours of nurses on this head, to point out that no danger follows their appearance; that, on the coutrary, the child is benefited by them; and that nature should be allowed to finish her own work.

Urticaria, or nettle-rash, is a papulous disease which generally occurs to children under two years of age. In its appearance it is always sudden, and is often very troublesome. The child generally begins to scream before the cause of its illness is known, and on examining its body and limbs, a resemblance so like the stinging of nettles is every where conspicuous, from which the disease has its name.

This complaint is generally preceded by a slight fever; some degree of sickness and pain in the head are also felt, particularly if the child have been exposed to cold.

The nettle-rash of children may be considered as a very simple disease, compared with that of adults. Its disappearance being often as sudden as its attack, it does not require that serious treatment necessary to more advanced age. When it seems obstinate, a few grains of the compound powder of contreyerva or ipecacuanha may be ad-

ministered two or three times a day, with the addition of two or three drops of compound spirit of ammonia. In the mean time, the state of the bowels, as in other papulæ, will require proper attention.

But if the eruption be very general, and the weather somewhat cold, it may not be an improper precaution to confine the child a day or two to bed, so that there may be no danger of the rash being repelled.

The last variety of infantile rash we shall mention, is a phlyctenous or watery eruption, consisting of blisters of different sizes, somewhat like scalds or burns, which continue out several days, and attend both bowel-complaints and toothing. It seems of a beneficial nature. It is chiefly conspicuous on the belly, ribs, and thighs. The vesicle or bag contains a sharp acrid liquor, which, where the bag is large, should be discharged by the puncture of a needle.

Little is here necessary in the way of treatment. The state of the bowels will entirely regulate what is to be done. If the child be costive the laxatives already prescribed will answer every purpose, with the addition of the testaceous powders: and, if the belly be loose, and the infant low and debilitated, then the light cordials previously recommended, will be necessary.

One of the most critical periods of infancy, and to which the greatest attention ought to be paid, is that of toothing, or dentition. A continued irritation is kept upon the constitution, for a great length of time, whereby the latent seeds of disease of an hereditary nature are often unfolded, which might otherwise have lain dormant, and done, perhaps, no injury to the general health. Hence cough, fever, rickets, and various forms of scrophula, may be traced in their first appearance, from this period.

It has been observed, in judging of the ease or difficulty of dentition, that weakly and rickety children cut their teeth most readily. Many circumstances have an influence in this respect, as the number of teeth that protude themselves at once, and the particular sort. Thus, where two or three teeth germinate at a time, the irritation on the gums must be much more considerable than where there is only one; and there will be more difficulty in the protrusion of the large back-teeth than in the fore or eye-teeth, the surface or points of which are better armed for cutting.

It has also been observed, that infants cut their teeth more readily in winter than in summer; and that all children who possess, naturally, a loose belly, suffer least from the complaints of this period.

The time of toothing generally commences between the fifth and tenth months, and the process of the first toothing continues till about eighteen or twenty months after birth. The usual number of the teeth at this time cut is sixteen. The process begins in the lower jaw, two of the front, or middle teeth, are usually first cut, which are followed by the two corresponding ones in the upper jaw; next, after some intermission, come the four adjoining teeth; then follow the two double-teeth, or grinders, at an interval of some weeks; then the teeth in the lower jaw called canine, or dog-teeth; and, lastly, the two corresponding ones in the upper jaw, called the eye-teeth. About the seventh year appears a new set of teeth; and about the twentieth, the two inner grinders, or wisdom-teeth, unless these, as sometimes happens, are protruded at the first toothing.

That the teeth of the lower jaw are most forward may be naturally expected, from their being less deep in the sockets, and their points thinner and sharper than the others.

Though this be the usual progress of protrusion in strong healthy children, yet in those more debilitated, the progress is both slower and more irregular. Thus the teeth are in many first cut in the upper jaw, nor do the contiguous ones appear always at the same time. Wherever there is much pain and irritation at first, the same may be expected to recur, or continue, during the whole period of toothing.

The morbid symptoms that attend dentition are very numerous; they may be arranged as simply affecting the part, or as connected with the system in general.

Of the former, the usual appearances are an increase of saliva discharged in the form of slaver. The gums are swelled, tense, and hot, while the cheeks display a circumscribed redness. Of the latter, or general symptoms, the most common are, cutaneous eruptions, particularly on the face and scalp; the state of the belly is irregular, though most commonly a looseness attends it, with stools of various colour and consistence. Considerable watchfulness prevails, and when the child procures sleep, it is interrupted by startings and spasms. The secretion of the urine is attended with the same irregularity; sometimes it is unduly increased, at other times diminished, and the appearance is equally varied, being

either of a milky colour, or depositing a brownish sediment. Sometimes mucous matter is mixed with the urine, and where there is pain in making water the irritation of the bladder is taken off by it, as well as the general fever. In all cases the child is subject to shrieking-fits, and its fingers are often thrust into its mouth. The feet and hands are also occasionally known to swell, though it be by no means a frequent occurrence, and only takes place where the bowels are in a costive state. Transient numbness of the legs and arms is also an occasional, but not a frequent, affection at this time. When these general symptoms are long continued, and prove severe on the constitution, they are often succeeded by an affection of the lungs, with cough and difficult breathing, and the attack of convulsions, general fever, scrophula, and atrophy, or consumption. A more rare effect of them is the formation of water in the head.

Difficult toothing, as a species of inflammatory disease, is to be treated as such. Besides keeping the body open by gentle purgatives, as well as by clysters, especially where there is a retention of urine, the skin should be relaxed, and gentle sweats produced by diluting drinks, and also by administering small quantities of tartarised antimonial wine, or James's powders. A discharge should likewise be encouraged by a blistering-plaster behind the ears, or on the back; and, on the first appearance of inflammation, a leech should be applied under each ear. A moderate looseness, being beneficial in toothing, should rather be encouraged than checked. In fevers from this cause, from fifteen to twenty drops of spirits of hartshorn, in a spoonful of water, may be given to advantage every four hours, in five or six doses; and where costiveness does not prevent, three or four drops of laudanum may be added to each dose.

Rubbing the gums with a little fine honey three or four times a day, and giving the child a crust of bread, roll of liquorice-root, wax-candle, or coral, to indulge the disposition for chewing which then presents itself, will afford ease; but the only means to be depended on, is scarification with a lancet; which takes off the tension of the gums, with scarcely any pain, and gives almost instantaneous relief to the child. The finger-nail, or a sharp-edged sixpence, are sometimes used for this little operation, but are clumsy substitutes: the lancet, in a proper hand, is infinitely preferable. Here, as in many other cases, from the nerves being braced by exercise in the open air, and the use of the cold bath, the dangers attendant on toothing will be much removed, and the child better able to support this painful and dangerous process, to which, and its concomitant disorders, so many children fall victims.

A frequent attendant upon dentition is convulsions. As this alarming symptom usually proceeds from the teeth cutting through the nervous membrane covering the jaw immediately under the gums, the scarification already recommended is not only useful to prevent this occurrence, but has, in many cases, saved the infant's life, after the most dangerous symptoms have taken place. It can never do harm, and may even be of service, though the fits should not proceed from toothing. Sometimes it will be necessary to repeat the lancing two or three times, which may always be done with perfect safety, and with almost certain success.

Lancing will also, in a great measure, prevent what is frequent in toothing, namely, ulcerated gums. When these take place they should be touched with honey, rendered astringent and moderately rough, by roch-allum and white vitriol, while the body is kept open.

We proceed to the very common complaint of convulsions; these are either symptomatic, produced by worms or dentition, or precursive of the measles, small-pox, or other eruptive fever; in which case, they are not necessarily to be regarded in an unfavourable view; or they are an original complaint arising from a morbid affection of the brain, or nervous fluid. Whatever stimulates the nerves in an immoderate degree may induce convulsions, as may also an irritation of the stomach or bowels, which is certainly either the predisposing or immediate cause of most of the convulsions of children.

We have already mentioned that for some months after birth, children should be confined to breast-milk. Where this is not the case, and the food is made too thick and pasty, convulsions are very frequent from the indigestion which naturally ensues. The bowels are thus disordered by occasioning their contents to turn pasty and cleave to their coats, so as to prevent the due adoption of the nutritious part of the aliment. Any offensive load, whether from the quality or quantity of food, excites

a morbid secretion, and that this is a cause of convulsions may be known from their being preceded by nausea, costiveness, or purging, pale countenance, swollen belly, and perturbed sleep. Repeated purges, particularly of castor-oil or calomel, with some light cordial, will be necessary and useful. Veal tea, mixed with milk, is the best nutriment; and if all farinaceous food be avoided, the convulsions may often, hereby alone, be prevented from appearing.

The children of the poor are not unfrequently afflicted with convulsions from foul air, and want of cleanliness in their skin and dress, a most extensive source of disease.

In convulsions arising from the irritation or foulness of the stomach and bowels, these must be cleansed as already mentioned; after which, if they appear to continue, spasmodic remedies must be administered, such as spirit of hartshorn, tincture of castor, rectified oil of amber, or two or three drops of laudanum. Bathing the feet in warm water, and friction all over the body, with camphor liniment, are likewise very useful.

When convulsion is a primary disease, proceeding immediately from the brain, bleeding, blistering, and purging, are requisite; and also bathing the feet in warm water, friction of the legs, and rubbing the soles of the feet with the compound spirit of ammonia. In delicate children, chalybeate-water may be useful; and where those of two or three years old are subject to slight and frequent fits, issues, or setons in the neck or between the shoulders, should be made, and kept open for a length of time.

Another, and the most serious, species of original convulsion, is attended with an unmeaning countenance, and constant stare and motion of the eyes, followed by a temporary deafness or blindness, and sometimes a loss of intellect. If water in the head be not suspected, and the common nervous medicines, with purges and blisters, have no effect, recourse must be had to repeated vomits, and bleeding with leeches; where the body continues in a good state the water of prepared kali may be beneficial as a diuretic. Much benefit has also been derived from a free use of musk, whether by the mouth or in the form of injections. When this sort of convulsion attacks young children, it terminates very soon, and too often fatally, especially if connected with water in the head.

After all, alarming as convulsions are, they are by no means either so generally fatal or injurious to the system as is commonly believed. Their number is far overstated in the bills of mortality; many children, in particular, being said to die under them who are really the victims of other disorders. An immediate and proper application will seldom fail to relieve the child, and as this may be necessary before professional assistance can be obtained; mothers, and those who have the care of children in such situations, should so far understand the subject as to enable them to give the immediate aid required. With this view, in addition to what has already been said, we may observe, that were the irritation proceeds from the bowels, the readiest remedy will be a soap clyster, with two or more tea-spoonfuls of salt, and afterwards the purgatives as before directed. But when the child falls suddenly into a convulsion, after sucking or feeding, and the bowels have been before regular, the irritation may be supposed to exist in the stomach; especially when there is an unusual paleness indicating sickness, or a considerable blackness with an appearance of suffocation: symptoms which may arise either from an overloaded stomach, or a small piece of indigested food irritating, and perhaps plugging up the inferior aperture of the stomach. Here, without waiting for a regular emetic, some immediate means may be tried to produce vomiting, as irritating the gullet with the finger or a feather, or throwing in a little smoke of tobacco, if it be at hand; any of which will provoke instant vomiting, and by relieving the stomach of the cause of oppression, put an end to the fit. This will be the better and more easily accomplished if the child be in the mean time supported by a hand placed under its stomach and belly. In every case it is necessary to clear the bowels; and in most cases, this is best accomplished by pretty brisk doses of calomel.

The next infantile disease we shall notice is hydrocephalus, or watery head. This is divided into external and internal. In the former, which is a very rare occurrence, the fluid lies on the surface of the brain; in the latter, much deeper, and within the ventricles, which, from the mass of water they contain are much distended, and often distend, to a monstrous size, the entire cranium.

External hydrocephalus, which sometimes appears immediately after birth, is a very distressing, and generally a very fatal disorder. A succession of blisters to different parts of the cranium, offers the best chance of cure.

Internal hydrocephalus seldom takes place before two, or after ten or twelve years of age. It may proceed from external injuries, from schirrous tumours, and excrescences within the scull, from a watery state of the blood, a diminished secretion of urine, a suddenly checked perspiration, or some lingering disease; and there are not wanting instances of its being hereditary; or, perhaps, it may be oftener referred to scrophula than to any other cause.

In young children it frequently begins with cough, a quick pulse, difficult respiration, flushed cheeks, a discharge from the nose and eyes, with continual heat and costiveness. The child often puts its hand to its head; and, during sleep, picks its nose, and grinds its teeth; the eyes are impatient of light, the vision imperfect, the countenance unmeaning, the hands tumid, and the fingers clinched. The most decided symptoms, however, are an inclination to lie on the back, a dislike to be moved, an increase of pain on the head being raised, and an almost continual drowsiness.

Though generally fatal, there are many instances of cures being effected by medicines; of which, those most worth trying are, stimulant embrocations, blisters applied to the head and neck, active purgatives and diuretics, with the external use of mercurial ointment. Strong sneezing powders, as white hellebore, or the compound powder of asarum, have often been recommended, as well as electricity; fox-glove, too, has been known to succeed, in conjunction, as it should, in this disease, always be given, with small doses of calomel. By the use of this conjoint plan, persevered in for a long time, and accompanied with frictions upon the scalp and spine of strong camphorated liniment, the writer of this article has seen many cases yield which were pronounced by several practitioners altogether intractable.

The last infantile disorder we shall notice is that of rickets. These generally show themselves, whenever they occur, between six months and two years of age. Rickets are evidently a disease of debility, and hence, whatever tends to debilitate, predisposes the constitution to their attack. On this account they are often apt to arise from unhealthy parents, and especially mothers who pass a sedentary life, in unwholesome air, and feed on a weak and watery diet; or from an improper nursing of children themselves, especially from their being kept wet, dirty, in a close damp air, and without due exercise. Hence they are most common among the children of poor people in manufacturing towns, the disease having, in fact, never appeared in this country till manufactures began to flourish. Children begotten by men at a late period of life, or by those afflicted with gout, gravel, or other chronic diseases, or who have suffered much from venereal complaints, are also very subject to rickets.

The disease first shows itself in a softness and flabbiness of the flesh; the child's countenance becomes bloated, or very florid, the belly and head enlarged, and the body debilitated; the pulse is quick and feeble, and the appetite and digestion bad. The teeth frequently rot early, and fall out; the wrists and ankles become unusually thick; the spine, or back-bone, assumes an unnatural shape; the breast is often deformed; and the bones of the arms and legs grow crooked.

Weakness and relaxation being the cause of this disorder, its remedy must, of course, consist in promoting digestion, and in bracing and strengthening the solids. Hence nourishing, and especially animal food, with a little port wine, is the proper diet. Air and exercise are indispensably necessary; the cold-bath, and if possible, of salt-water, will be of essential service, especially in summer; but it should not be entered on without previous purging. Frictions afterwards with flannel and aromatic powders, or liniments, or the fumes of frankincense, mastic, or amber, especially on the back and belly, will contribute to strengthen the habit. Bark, columbo, steel, and tincture of myrrh, are also to be recommended where they can be employed. If the child be of a gross habit, gentle emetics, with warm and active aperients, will be of use; it being necessary to reduce the tympanum of the belly, and to strengthen the action of the intestinal canal. Though this complaint be seldom suddenly vanquished, yet by attention to regimen, and particularly to air and exercise, in conjunction with the medical plan now prescribed, it will generally be overpowered by degrees.

INFANT. From the observations daily made on the actions of infants, as to their arriving at discretion, the law and customs

of every country have fixed upon particular periods, on which they are presumed capable of acting with reason and discretion; in our law, the full age of man or woman is twenty-one years. The ages of male and female are different for different purposes: a male at twelve years of age may take the oath of allegiance; at fourteen, is of years of discretion, and therefore may consent or disagree to marriage, may choose his guardian, and if his discretion be actually proved, may make his testament of his personal estate; at seventeen, may be a procurator or an executor; and at twenty-one is at his own disposal, and may alien his lands, goods, and chattels. A female at seven years of age may be betrothed or given in marriage; at nine, is intitled to dower; and at twelve, is of years of maturity, and therefore may consent or disagree to marriage, and, if proved to have sufficient discretion, may bequeath her personal estate; at fourteen, is at years of legal discretion, and may choose a guardian; at seventeen, may be executrix; and at twenty-one, may dispose of herself and her lands. An infant is capable of inheriting, for the law presumes him capable of property; also an infant may purchase, because it is intended for his benefit, and the freehold is in him till he disagree thereto, because an agreement is presumed, it being for his benefit, and because the freehold cannot be in the grantor contrary to his own act, nor can be in abeyance, for then a stranger would not know against whom to demand his right; and if at his full age the infant agree to the purchase, he cannot afterwards avoid it; but if he die during his minority, his heirs may avoid it; for they shall not be bound by the contracts of a person, who wanted capacity to contract. As to infants being witnesses, there seems to be no fixed time at which children are excluded from giving evidence; but it will depend, in a great measure, on the sense and understanding of the children, as it shall appear on examination in court.

An infant is not bound by his contract to deliver a thing; so if one deliver goods to an infant upon a contract, &c., knowing him to be an infant, he shall not be chargeable in trover and conversion, or any other action for them; for the infant is not capable of any contract but for necessaries; therefore such delivery is a gift to the infant; but if an infant, without any contract, wilfully take away the goods of another, trover lies against him. Also it is said, that if he take the goods under pretence that he is of full age, trover lies, because it is a wilful and fraudulent trespass. Infants are disabled from contracting for any thing but necessaries for their person, suitable to their degree and quality, and what is necessary must be left to the jury.

An infant, knowing of a fraud, shall be as much bound as if of age. But it is held, that this rule is confined to such acts only as are voidable, and that a warrant of attorney, given by an infant, being absolutely void, the court will not confirm it, though the infant appeared to have given it, knowing it was not good, and for the purpose of collusion.

As to acts of infants being void, or only voidable, there is a difference between an actual delivery of the thing contracted for, and a bare agreement to deliver it; the first is voidable, but the last absolutely void. As necessaries for an infant's wife are necessaries for him, he is chargeable for them, unless provided before marriage; in which case he is not answerable, though she wore them afterward. An infant is also liable for the nursing of his lawful child. Where goods are furnished to the son, he is himself liable, if they be necessaries. If tradesmen deal with him, and he undertakes to pay them, they must resort to him for payment; but if they furnished the infant on the credit of his father, the father only is liable. With respect to education, &c., infants may be charged, where the credit was given, *bona fide*, to them. But where the infant is under the parents' power, and living in the house with them, he shall not be liable even for necessaries.

If a tailor trust a young man under age for cloaths, to an extravagant degree, he cannot recover; and he is bound to know whether he deals at the same time with any other tailor.

A promissory note given by an infant for board and lodging, and for teaching him a trade, is valid, and an action will lie for the money. And debts contracted during infancy, are good considerations to support a promise made, when a person is of full age to pay them; but the promise must be express. A bond, without a penalty, for necessaries, will bind an infant; but not a bond with a penalty. Legacies to infants cannot be paid either to them or their parents. An infant cannot be a juror, neither can he be an attorney, bailiff, factor, or receiver.

By the custom of London, an infant unmarried, and above the age of fourteen, if under twenty-one, may bind himself apprentice to a freeman of London, by indenture, with proper covenants, which covenants, by the custom of London, will be as binding as if of age.

If an infant draw a bill of exchange, yet he shall not be liable on the custom of merchants, but he may plead infancy in the same manner as he may to any other contract.

An action on an account stated, will not lie against an infant, though it be for necessaries.

INFANTRY, in military affairs, denotes the whole body of foot-soldiers.

INFINITE, that which has neither beginning nor end: in which sense God alone is infinite. See God.

Infinite, or Infinitely *great line* in geometry, denotes only an indefinite or indeterminate line, to which no certain bounds, or limits, are prescribed.

Infinite *quantities.* The very idea of magnitudes infinitely great, or such as exceed any assignable quantities, does include a negation of limits: yet if we nearly examine this notion, we shall find that such magnitudes are not equal among themselves, but that there are really besides infinite length and infinite area, three several sorts of infinite solidity; all of which are *quantitates sui generis*, and that those of each species are in given proportions.

Infinite length, or a line infinitely long, is to be considered either as beginning at a point, and so infinitely extended one way, or else both ways from the same point; in which case the one, which is a beginning infinity, is the one half of the whole, which is the sum of the beginning and ceasing infinity; or, as may be said, of infinity *a parte ante* and *a parte post*, which is analogous to eternity in time and duration, in which there is always as much to follow as is past, from any point or moment of time: nor doth the addition or subduction of finite length, or space of time, alter the case either in infinity or eternity, since both the one or the other cannot be any part of the whole. As to infinite surface, or area, any right line, infinitely extended both ways on an infinite plane, does divide that infinite plane into equal parts, the one to the right, and the other to the left of the said line; but if from any point, in such a plane, two right lines be infinitely extended, so as to make an angle, the infinite area, intercepted between those infinite right lines, is to the whole infinite plane as the arch of a circle, on the point of concourse of those lines as a centre, intercepted between the said lines, is to the circumference of the circle; or, as the degrees of the angle to the three hundred and sixty degrees of a circle: for example, right lines meeting at a right angle do include, on an infinite plane, a quarter part of the whole infinite area of such a plane.

But if two parallel infinite lines be supposed drawn on such an infinite plane, the area intercepted between them will be likewise infinite; but at the same time will be infinitely less than that space, which is intercepted between two infinite lines that are inclined, though with never so small an angle; for that, in the one case, the given finite distance of the parallel lines diminishes the infinity in one degree of dimension; whereas, in a sector there is infinity in both dimensions: and consequently the quantities are the one infinitely greater than the other, and there is no proportion between them.

From the same consideration arise the three several species of infinite space or solidity; for a parallelopiped, or a cylinder, infinitely long, is greater than any finite magnitude, how great soever; and all such solids, supposed to be formed on given bases, are as those bases in proportion to one another. But if two of these three dimensions are wanting, as in the space intercepted between two parallel planes infinitely extended, and at a finite distance, or with infinite length and breadth, with a finite thickness, all such solids shall be as the given finite distances one to another; but these quantities, though infinitely greater than the other, are yet infinitely less than any of those wherein all the three dimensions are infinite. Such are the spaces intercepted between two inclined planes infinitely extended; the space intercepted by the surface of a cone, or the sides of a pyramid, likewise infinitely continued, &c. of all which notwithstanding, the proportions one to another, and to the το πάν, or vast abyss of infinite space (wherein is the locus of all things that are or can be; or to the solid of infinite length, breadth and thickness taken all manner of ways) are easily assignable; for the space between two planes is to the whole as the angle of those planes to the three hundred and sixty degrees of the circle. As for cones and

pyramids, they are as the spherical surface intercepted by them is to the surface of the sphere, and therefore cones are as the versed sines of half their angles to the diameter of the circle: these three sorts of infinite quantity are analogous to a line, surface, and solid; and, after the same manner, cannot be compared, or have no proportion the one to the other.

INFINITESIMALS, among mathematicians, are defined to be infinitely small quantities. In the method of infinitesimals, the element, by which any quantity increases or decreases, is supposed to be infinitely small, and is generally expressed by two or more terms, some of which are infinitely less than the rest, which being neglected as of no importance, the remaining terms form what is called the difference of the proposed quantity. The terms that are neglected in this manner, as infinitely less than the other terms of the element, are the very same which arise in consequence of the acceleration, or retardation, of the generating motion, during the infinitely small time in which the element is generated; so that the remaining terms express the elements that would have been produced in that time, if the generating motion had continued uniform: therefore those differences are accurately in the same ratio to each other as the generating motions or fluxions. And hence, though in this method infinitesimal parts of the elements are neglected, the conclusions are accurately true without even an infinitely small error, and agree precisely with those that are deduced by the method by fluxions.

In order to render the application of this method easy, some analogous principles are admitted, as that the infinitely small elements of a curve are right lines, or that a curve is a polygon of an infinite number of sides, which being produced, give the tangents of the curve; and by their inclination to each other measure the curvature. This is as if we should suppose, when the base flows uniformly, the ordinate flows with a motion which is uniform for every infinitely small part of time, and increases or decreases by infinitely small differences at the end of every such time.

But however convenient this principle may be, it must be applied with caution and art on various occasions. It is usual therefore, in many cases, to resolve the element of the curve into two or more infinitely small right lines; and sometimes, it is necessary, if we would avoid error, to resolve it into an infinite number of such right lines, which are infinitesimals of the second order. In general, it is a postulatum in this method, that we may descend to the infinitesimals of any order whatever, as we find it necessary; by which means, any error that might arise in the application of it may be discovered and corrected by a proper use of this method itself. See Maclaurin's Fluxions.

INFLAMMATION. See MEDICINE and SURGERY.

INFLAMMATION, in chemistry, is combustion attended with flame: under the article COMBUSTION, we have referred to the spontaneous inflammation of certain bodies, in peculiar circumstances, and likewise to the combustion of living individuals in the human species. We shall in this place mention some of the causes of spontaneous inflammation. The heat produced by friction; the slacking of lime when in contact with combustible matter, the fermentation of hay, dunghills, &c. are well known. Many vegetable substances, highly dryed and heaped together will heat, scorch, and at last burst in a flame. A mixture of linseed, or rape oil, with almost any dry vegetable fibre, as hemp, cotton, matting, &c. and still more if united to certain carbonaceous matters, will in time, if in a warm place, burst out into a flame. To this circumstance many alarming and destructive fires are to be imputed, which at the time were supposed to have been occasioned by wilful crime. In 1781 a large magazine of hemp was destroyed in this way, at Cronstadt: and in the summer of 1794 an accident of this sort happened at Gainsborough, with a bale of yarn accidentally soaked in rape oil, which after remaining in the warehouse for several days began to smoke, and finally to burst out in a most violent flame. A similar accident happened at Bombay. A bottle of linseed oil had been thrown down in the night, the oil had penetrated into a chest of coarse cotton cloth, and in the morning the cloth was found reduced nearly to a cinder, and the wood of the chest completely charred in the inside. An experiment was immediately made to ascertain the true cause: a piece of the same cloth was dipped in the same sort of oil, and shut up in a box, and in three hours it was found scorching hot, and on opening the box it burst into a flame. Hence the spontaneous combustion of wool, or woollen yarn, which has sometimes happened when large quan-

tities have been kept in heaps without the access of fresh air. The oil with which it is dressed seems to be the chief cause of combustion. Wheaten flour and charcoal reduced to powder, and heated in large quantities have been known to take fire spontaneously.

The cases of the spontaneous human combustion have never been satisfactorily accounted for; the facts themselves seem to be well authenticated, two are recorded in the Philosophical Transactions, and referred to under COMBUSTION. They ought however to hold out a lesson of warning to those habitually given to excess with regard to spirituous liquors; for in every case, the subjects of this terrible calamity were drunkards, whose favourite liquor was alcohol, in the shape of brandy, gin, &c.

INFLECTION, or *point of inflection*, in the higher geometry, is the point where a curve begins to bend a contrary way. See FLEXURE.

There are various ways of finding the point of inflection; but the following seems to be the most simple. From the nature of curvature it is evident, that while a curve is concave towards an axis, the fluxion of the ordinate decreases, or is in a decreasing ratio, with regard to the fluxion of the absciss; but, on the contrary, that the said fluxion increases, or is in an increasing ratio to the fluxion of the absciss, where the curve is convex towards the axis; and hence it follows that those two fluxions are in a constant ratio at the point of inflection, where the curve is neither concave nor convex. That is, if $x =$ the absciss, and $y =$ the ordinate, then $\dot{x}$ is to $\dot{y}$ in a constant ratio, or $\frac{\dot{x}}{\dot{y}}$ or $\frac{\dot{y}}{\dot{x}}$ is a constant quantity. But constant quantities have no fluxion, or their fluxion is equal to nothing; so that in this case the fluxion of $\frac{\dot{x}}{\dot{y}}$ or of $\frac{\dot{y}}{\dot{x}}$ is equal to nothing. And hence we have this general rule: *viz.* put the given equation of the curve into fluxions; from which equation of the fluxions find either $\frac{\dot{x}}{\dot{y}}$ or $\frac{\dot{y}}{\dot{x}}$; then take the fluxion of this ratio or fraction, and put it equal to 0 or nothing; and from this last equation find also the value of the same $\frac{\dot{x}}{\dot{y}}$ or $\frac{\dot{y}}{\dot{x}}$: then put this latter value equal to the former, which will be an equation from whence, and the first given equation of the curve, x and y will be determined, being the absciss or ordinate answering to the point of inflection in the curve. Or, putting the fluxion of $\frac{\dot{x}}{\dot{y}}$ equal to 0, that is $\frac{\ddot{x}\dot{y} - \dot{x}\ddot{y}}{y^2} = 0$, or $\ddot{x}\dot{y} - \dot{x}\ddot{y} = 0$, or $\dot{x}\ddot{y} = \dot{x}\ddot{y}$, or $\dot{x} : \dot{y} :: \ddot{x} : \ddot{y}$, that is, the second fluxions have the same ratio as the first fluxions, which is a constant ratio; and therefore if $\dot{x}$ be constant, or $\ddot{x} = 0$, then shall $\ddot{y}$ be $= 0$ also; which gives another rule, *viz.* take both the first and second fluxions of the given equation of the curve, in which make both $\ddot{x}$ and $\ddot{y} = 0$, and the resulting equations will determine the values of x and y, or absciss and ordinate answering to the point of inflection.

To determine the point of inflection in curves, whose semi-ordinates CM, Cm (Plate Miscel. VII. fig. 13 and 14.) are drawn from the fixed point C; suppose C M to be infinitely near C m, and make $m\,\mathrm{H} = \mathrm{M}\,m$; let T m touch the curve in M. Now the angles C m T, C M m, are equal; and so the angle C m H, while the semi-ordinates increase, does decrease, if the curve is concave towards the centre C, and increases if the convexity turns towards it. Whence this angle, or, which is the same, its measure will be a minimum or maxium, if the curve has a point of inflection or retrogression; and so may be found, if the arch T H, or fluxion of it, be made equal to 0, or infinity. And in order to find the arch T H, draw m L, so that the angle T m L be equal to m C L; then if $\mathrm{C}m = y$, $mr = \dot{x}$, $m\mathrm{T} = \dot{t}$, we shall have $y : \dot{x} :: \dot{t} : \frac{\dot{t}\dot{x}}{y}$. Again draw the arch H O to the radius C H; then the small right lines $m\,r$, O H, are parallel; and so the triangles O L H, m L r, are similar; but because H I is also perpendicular to m L, the triangles L H I, $m\,r$, are also similar: whence $\dot{t} : \dot{x} :: y : \frac{\dot{x}\dot{y}}{\dot{t}}$; that is, the quantities m T, m L, are equal. But H L is the fluxion of H r, which is the distance of $\mathrm{C}\,m = y$; and H L is a negative quantity, because while the ordinate C M increases, their difference r H decreases; whence $\dot{x}x + \dot{y}y - \dot{y}\dot{y} = 0$, which is a general equation for finding the point of inflection, or retrogradation.

INFLECTION, in grammar, the variation of nouns and verbs, by declension and conjugation. See GRAMMAR.

INFLORESCENCE, in botany, a term

used to denote the mode of flowering; the manner in which flowers are supported on their footstalks. The various modes in which flowers are joined to the plant by the peduncles or foot-salk are expressed by different terms. See BOTANY.

The various modes of flowering are applicable to those flowers which proceed from the angle formed by the leaves and branches, as is the case in most instances, and to such also as terminate the stem and branches. In the first case, flowers are termed "axillares," that is proceeding from the arm-pit of the leaf: in the latter "terminales," that is, the terminating the branches. Inflorescence affords a characteristic mark, by which to distinguish the species of plants, but is not used as a generic difference.

INFLUENZA, in medicine, a species of contagious catarrh, so named because it was supposed to be produced by a peculiar influence of the stars. The phenomena of contagious catarrhs have been much the same with those of the simple kind, but the disease has always been particularly remarkable for this, that it has been the most widely and generally spreading epidemic known. It has seldom appeared in any one country of Europe, without appearing successively in most of the others.

IN FORMA PAUPERIS. When any man who has a just cause of suit, either in Chancery or any of the courts of common law, will come before the Lord Keeper, Master of the Rolls, either of the Chief Justices, or Chief Baron, and make oath, that he is not worth five pounds, his debts paid; either of the said judges will, in his own proper court, admit him to sue in *forma pauperis*, or as a poor man, and he shall have counsel, clerk, or attorney assigned him, to do his business, without paying any fees.

INFORMATION, in law, may be defined an accusation or complaint exhibited against a person for some criminal offence. It differs principally from an indictment in this, that an indictment is an accusation found by the oath of twelve men, but an information is only the allegation of the officer who exhibits it. Informations are of two kinds; first, those which are partly at the suit of the king, and partly at the suit of a subject, and secondly, such as are only in the name of the king: the former are usually brought upon penal statutes, which inflict a penalty on conviction of the offender, one part to the use of the king, and another to the use of the informer, and are a sort of *qui tam* or popular actions, only carried on by a criminal instead of a civil process. Informations that are exhibited in the name of the king alone are also of two kinds; first, those which are truly and properly his own suits, and filed *ex officio* by his own immediate officer, the Attorney-General; secondly, those in which, though the King is the nominal prosecutor, yet it is at the relation of some private person, or common informer, and they are filed by the Master of the Crown-office, under the express direction of the court. And when an information is filed in either of these ways, it must be tried by a petit jury of the county where the offence arises; after which, if the defendant be found guilty, he must resort to the Court of King's Bench for his punishment. Common informers, by 18 Elizabeth, c. 5, are to pay costs in case of failure of suit upon informations, unless the judge certifies that there was a reasonable cause for prosecuting.

INFUSION, in chemistry, is the maceration of any substance in water, or any other liquid, hot or cold, in order to extract its soluble parts. The liquid thus impregnated is called an infusion. Infusion differs from maceration, in being continued for a longer time, and it can only be employed for substances which do not easily ferment or spoil. See PHARMACY.

INFUSORIA, in natural history, the fifth order of the class Vermes, in the Linnæan system. They are simple microscopic animalcules. There are three divisions:

A, with external organs, of which there are five genera, *viz.*

Branchionus,	Trichoda,
Cercaria,	Vorticella,
Leucopera.	

B, without external organs, flattened; four genera:

Colpoda,	Gonium,
Cyclidium,	Paramecium.

C, without external organs, round; six genera:

Bacillaria,	Monas,
Bursaria,	Vibria,
Euchelis,	Volvox.

This order, Infusoria, is scarcely distinguished from the Intestina and Mollusca, by any other character than the minuteness of the individuals belonging to it, and their spontaneous appearance in animal and vegetable infusions, where we can discover no

traces of the manner in which they are produced. The process, by which their numbers are sometimes increased, is no less astonishing than their first production. Several of the genera often seem to divide spontaneously into two or more parts, which become new and distinct animals. The volvox, and some of the vorticellæ, are remarkable for their continual rotatory motion, supposed to be intended for the purpose of straining their food out of the water: while other species of the vorticella resemble fungi or corallines in miniature.

INGOT, in the arts, is a small bar of metal made of a certain form and size, by casting it in hollowed iron or brass plates, called ingot moulds. The term is chiefly applied to the small bars of gold and silver, intended either for coining or exportation to foreign countries.

INHALER, a machine used for steaming the lungs with the vapour of hot water, for the cure of a cough, cold, inflamed throat, &c.

INHERITANCE, in law, is a perpetuity in lands or tenements to a man and his heirs; and the word inheritance is not only intended where a man has lands or tenements by descent, but also every fee-simple, or fee-tail, which a person has by purchase, may be said to be an inheritance, because his heirs may inherit it. Inheritances are corporeal or incorporeal. Corporeal inheritances relate to houses and lands, which may be touched or handled; and incorporeal hereditaments are rights issuing out of, annexed to, or exercised with corporeal inheritances, as advowsons, tithes, annuities, offices, commons, franchises, privileges, and services. There are several rules of inheritances of lands, according to which estates are transmitted from ancestor to heir; *viz.* 1. That inheritances shall lineally descend to the issue of the person last actually seized, *in infinitum*, but shall never lineally ascend. 3. Where there are two or more males in equal degree, the eldest only shall inherit; but the females altogether. 4. The lineal descendants, *in infinitum*, of any person deceased shall represent their ancestor; that is, shall stand in the same place as the person himself would have done had he been living: thus the child, grand-child, or great grandchild, (either male or female) of the eldest son succeeds before the younger son, and so *in infinitum*. 5. On failure of issue of the person last seized, the inheritance shall descend to the blood of the first purchaser. 6. The collateral heir of the person last seized must be his next collateral kinsman of the whole blood. 7. In collateral inheritances the male stocks shall be preferred to the female, unless where lands are descended from a female: thus the relations on the father's side are admitted *in infinitum* before those on the mother's side are admitted at all, and the relations of the father's father before those of the father's mother, and so on.

INJECTION, in surgery, the forcibly throwing certain liquid medicines into the body, by means of a syringe, tube, clyster-pipe, or the like.

INJECTION, *anatomical*, the filling the vessels with some coloured substance, in order to make their figures and ramifications visible.

INJUNCTION, in law, is a prohibitory writ, restraining a person from committing or doing a thing which appears to be against equity and conscience. An injunction is usually granted for the purpose of preserving property in dispute pending a suit; as to restrain the defendant from proceedings at the common law against the plaintiff, or from committing waste, or doing any injurious act. Injunctions issue out of the courts of equity in several instances: the most usual injunction is to stay proceedings at law, as if one bring an action at law against another, and a bill be brought to be relieved either against a penalty or to stay proceedings at law, on some equitable circumstances, of which the party cannot have the benefit at law. In such case the plaintiff in equity may move for an injunction either upon an attachment, or praying a dedimus, or praying a farther time to answer; for it being suggested in the bill that the suit is against conscience, if the defendant be in contempt for not answering, or pray time to answer, it is contrary to conscience to proceed at law in the mean time, and therefore an injunction is granted of course; but this injunction only stays execution touching the matter in question, and there is always a clause giving liberty to call for a plea to proceed to trial, and for want of it to obtain judgment; but execution is stayed till answer, or farther order. The methods of dissolving injunctions are various.

INK, *common writing*. The preparation of common writing ink is a subject of great importance in technical chemistry. A good ink is of a proper consistence to flow freely from the pen, of a full deep black, so permanent as to remain for a number of years

without materially fading or becoming illegible, dries very soon after writing with it, and does not considerably corrode or soften the pen. The basis of all the common writing inks is the fine black, or dark blue precipitate, formed by the addition of vegetable astringents, and particularly the soluble part of the gall-nut, to a solution of iron, generally the sulphate. But as this, if diffused in water alone, would subside in a short time, and leave the supernatant liquor nearly without colour, the precipitate is kept suspended, by thickening the water with gum arabic, or any other gum mucilage, which also gives the ink the due consistence, and enables it to trace a fine stroke on the paper, without running. These materials, therefore, that is, gall-nuts, green vitriol, (sulphate of iron) gum arabic, and water, are all that are necessary for the composition of ink; and if they are of good quality, and properly proportioned to each other, every other addition usually made adds very little to its perfection.

It is not well ascertained how soon the present kind of writing ink came into use. It has certainly been employed for many centuries in most European countries; but the ancient Roman inks were, for the most part, of a totally different composition, being made of some vegetable carbonaceous matter like lamp-black diffused in a liquor. The Chinese, and many of the inks used by the Oriental nations, are still of this kind.

On the subject of the common writing ink, Dr. Lewis ("Commerce of Arts") has so full and so accurate an investigation, and his experiments are so simple and well devised, that little else can be added to the subject in a technical point of view. For a fuller chemical inquiry into the nature of the atramentous precipitate, the reader is referred to the articles Gallic Acid and Iron.

Dr. Lewis first endeavoured to ascertain the best proportion between the galls and the sulphate of iron, to render the ink permanent; for it is to be observed, that with almost any proportions, if the entire quantity be sufficient, the ink will be fine and black at first, but many of these inks if kept for some time, especially exposed to light and air, will grow brown and fade, and the letters made with it will become nearly illegible.

By trying different proportions of galls and sulphate of iron, it was found, that when about in equal quantities (the galls being powdered, and boiled fully to extract their soluble parts) they appeared to be mutually saturated, so that the mixed liquors would receive no additional blackness, from a further dose of one or the other.

This, however, was only a rough approximation to accuracy, for the same effect was produced when either substance was also in a small degree superior in quantity to the other. But Dr. Lewis found that an ink, with equal parts of the two, though very black at first, changed to a yellowish brown, upon exposure to the sun and air only for a few days. This was again blackened by washing with fresh gall infusion, and hence it appears in fair inference that the galls are a perishable substance, so that to insure durability, a much greater proportion must enter into the ink than is required for mere saturation in the first instance. Thus it was found that two parts of galls and one of vitriol, make a much more durable ink than with equal parts, and three of galls with one of vitriol was still more durable. When the galls were increased beyond this point, the colour was indeed quite permanent, but it was not of so full a black.

The proportion of water or other liquid to the solid ingredients, will admit of great variation. One part of vitriol, three of galls, and fifty parts of water, gave an ink black enough for common use; but the finest and blackest was made when only ten of water were employed; nor was any deficiency in the gallic acid observed after fifteen years, though the water was scarcely more than sufficient to cover the galls, and therefore could hardly be supposed capable of extracting all the soluble part of them; and though the vitriol from its greater solubility would probably be dissolved entirely, and thus be in greater proportion than usual. Other liquors besides water were tried. Of these, white wine and vinegar appeared to answer somewhat better; but any considerable proportion of spirit of wine, or brandy, obviously did harm, owing to the insolubility of the sulphate of iron (as of all the other sulphates) in alcohol, and therefore its diminished solubility in any liquor is in proportion to the alcohol it contains. A decoction of logwood used instead of water sensibly improved the beauty of the colour.

Instead of galls other astringents were employed, such as sloes, oak-bark, tormentil root, &c.; but though they all gave a good blue black, with the salt of iron, none

of them was equal to the gall-nut in this respect.

Other salts of iron were also substituted to the sulphate. The muriate and nitrate of iron nearly equalled the sulphate in colour, but proved too corrosive to the paper, and as they were in no respect preferable to the sulphate, there is no reason for abandoning it.

Imagining that there must be some excess of sulphuric acid in common ink, to which the fading might be imputed, Dr. Lewis tried to neutralize it by lime and alkalies, but with manifest injury, the colour being rendered thereby extremely fugitive. Another ingenious idea for avoiding the supposed excess of acid, was to separate the black atramentous precipitate, wash it, and again diffuse it with water thickened with gum. This, indeed, makes a very good ink, but with the capital defect of not remaining so long suspended in the liquor, and especially of not fixing itself to the paper like common ink, but rather only slightly adhering like a weak gum varnish, and was readily washed off by water. Hence it appears that the acid of the salt of iron acts as a kind of mordant or intermede, between the atrementous precipitate and the paper, and causes a degree of chemical union between them; a real advantage which this species of ink possesses over all the lamp-black, or China inks, which, indeed, are rather black varnishes.

With regard to the gummy ingredient, the effect of which is rather mechanical, it was found that any other gum-mucilage would answer as well; but not glue, isinglass, nor animal jelly of any kind. Besides, as these latter putrify by keeping, this alone would be a strong objection.

Sugar is sometimes added to ink. It makes it flow somewhat easier from the pen, and gives it when dry a gloss which is admired by some. It has this quality, however, of making it very slow in drying, which in most cases is an inconvenience.

On account of the great improvements to the black atramentous dye produced by adding sulphate of copper, some have recommended this addition to common ink, which is composed of the same materials; but it does not appear that the same advantage is here obtained, and Dr. Lewis thinks it an useless addition.

From the above observations, Dr. Lewis gives the following receipt for the composition of ink: put into a stone or glass bottle, or any other vessel, three ounces of finely powdered galls, one ounce of green vitriol, one ounce of logwood finely rasped or bruised, one ounce of gum-arabic, and a quart of soft water: shake the bottle well, and let the ingredients stand in a moderately warm place for a week or ten days, shaking it frequently in the day. It is then fit for use; but a little before it is put into the ink-stand, it is better to shake the bottle that the colour may be more uniformly diffused.

To prevent the ink from moulding, Hoffman recommends half a dozen cloves to be bruised with the gum-arabic, and put into the bottle. This appears a useful addition. Instead of water alone, where a very fine ink is wanted, white wine, or vinegar and water, may be used.

If the ink be wanted for use in a very short time, the galls and logwood may be boiled for half an hour in the water, adding a little more to supply the waste, and the decoction while hot strained off through a cloth, and the gum arabic and cloves, and the sulphate of iron, both in fine powder, added to the decoction when in the bottle and shaken. The ink will then be fit for use almost immediately after the latter ingredients are dissolved. It will be improved by adding to the bottle some pieces of gall-nut coarsely bruised. Ink kept in a close bottle is always rather pale; but it blackens by exposure to air in a few hours; and probably in this way the colour is somewhat more durable than if it were brought by previous exposure to its full colour at once.

It has been mentioned that sugar renders ink slow in drying. Advantage is ingeniously taken of this property in enabling it to give one, and sometimes two impressions on soft paper, when strongly pressed. In this simple way letters are copied in merchant's counting-houses, and offices of business. A little sugar is mixed with the ink, the writing-sheet is laid on the copying press, a blank sheet of porous and damped paper is put over it, and by the pressure of the machine a perfect fac-simile of the writing is struck off, sufficiently legible for all purposes.

This ingenious method saves a vast quantity of labour usually bestowed in copying letters, and besides prevents all possibility of mistakes.

Sometimes the ink of very old writings is so much faded by time as to be illegible. Dr. Blagden, (Philosophical Transactions, vol. lxxvii.) in his experiments on this sub-

ject, found that in most of these the colour might be restored, or rather a new body of colour given, by penciling them over with a solution of prussiate of potash, and then with a dilute acid, either sulphuric or muriatic; or else *vice versa*, first with the acid, and then with the prussiate. The acid dissolves the oxide of iron of the faded ink, and the prussiate precipitates it again of a blue, which restores the legibility of the writing. If this be done neatly, and blotting paper laid over the letters as fast as they become visible, their form will be retained very distinctly. Pencilling over the letters with an infusion of galls also restores the blackness to a certain degree, but not so speedily nor so completely.

The blackness of common ink is almost instantly and irrevocably destroyed by the oxymuriatic acid, and hence any writing may be effaced by this method completely. To prevent this mischief, which might often be a serious one, several additions have been proposed to common ink, of which by far the best is lamp-black or charcoal, in impalpable powder, on which the acid has no effect. The lamp-black should be of the least oily kind, as it does not readily mix with the ink, and some pains must be taken to incorporate them. On this account perhaps common charcoal is preferable. About a quarter of the weight of the vitriol used will be amply sufficient. This will not fade by age.

Ink, *China or Indian*. The well known and much admired Indian or China ink, is brought over in small oblong cakes, which readily become diffused in water by rubbing, and the blackness remains suspended in it for a considerable time, owing to the extreme subtlety of division of the substance that gives the colour, and the intimacy with which it is united to the mucilaginous matter that keeps it suspended.

Indian ink does, however, deposit the whole of its colour by standing, when it is diffused in a considerable quantity of water. Dr. Lewis, on examining this substance, found that the ink consisted of a black sediment, totally insoluble in water, which appeared to be of the nature of the finest lamp-black, and of another substance soluble in water, and which putrified by keeping, and when evaporated left a tenacious jelly exactly like glue or isinglass. It appears probable, therefore, that it consists of nothing more than these two ingredients, and probably may be imitated with perfect accuracy by using a very fine jelly, like isinglass or size, and the finest lamp-black, and incorporating them thoroughly. The finest lamp-black known is made from ivory-shavings, and thence called ivory-black.

Ink, *printer's*. This is a very singular composition, partaking much of the nature of an oil varnish, but differing from it in the quality of adhering firmly to moistened paper, and in being to a considerable degree soluble in soap-water.

It is, when used by the printers, of the consistence of rather thin jelly, so that it may be smeared over the types readily and thinly, when applied by leather cushions, and it dries very speedily on the paper without running through to the other side, or passing the limits of the letter.

The method of making printer's ink is thus described by Dr. Lewis. Ten or twelve gallons of nut-oil are set over the fire in a large iron pot, and brought to boil. It is then stirred with an iron ladle, and whilst boiling, the inflammable vapour rising from it either takes fire of itself or is kindled, and suffered to burn in this way for about half an hour, the pot being partially covered so as to regulate the body of the flame, and consequently the heat communicated to the oil. It is frequently stirred during this time, that the whole may be heated equally, otherwise a part would be charred and the rest left imperfect. The flame is then extinguished by entirely covering the pot. The oil by this process has much of its unctuous quality destroyed, and when cold is of the consistence of soft turpentine, and is then called varnish. After this it is made into ink by mixture with the requisite quantity of lamp-black, of which about two ounces and a half are sufficient for sixteen ounces of the prepared oil. The oil loses by the boiling about an eighth of its weight, and emits very offensive fumes. Several other additions are made to the oil during the boiling, such as crusts of bread, onions, and sometimes turpentine. These are kept secret by the preparers. The intention of them is more effectually to destroy part of the unctuous quality of the oil, to give it more body, to enable it to adhere better to the wetted paper, and to spread on the types neatly and uniformly.

Besides these additions, others are made by the printers, of which the most important is generally understood to be a little fine indigo in powder, to improve the beauty of the colour.

Red printer's ink, is made by adding to the varnish, about half its weight of vermi-

lion. A little carmine also improves the colour. (Encycl. Arts & Metiers, vol. iii. p. 518.)

INKS, *coloured.* Few of these are used except red ink. The preparation of these is very simple, consisting either of decoctions of the different colouring or dying materials in water, and thickened with gum-arabic, or of coloured metallic oxides or insoluble powders, merely diffused in gum-water. The proportion of gum-arabic to be used may be the same as for black writing ink. All that applies to the fixed or fugitive nature of the several articles used in dying, may be applied in general to the use of the same substances as inks.

INK, *red,* is usually made by boiling about two ounces of Brazil wood in a pint of water, for a quarter of an hour, and adding to the decoction the requisite quantity of gum, and about half as much alum. The alum both heightens the colour and makes it less fugitive. Probably a little madder would make it more durable.

INK, *blue,* may be made by diffusing Prussian blue or indigo through strong gum-water.

INK, *yellow,* may be made by a solution of gamboge in gum-water.

Most of the common water-colour cakes diffused in water, will make sufficiently good coloured inks for most purposes.

Inks of other colours may be made from a strong decoction of the ingredients used in dying, mixed with a little alum and gum arabic. For example, a strong decoction of Brazil wood, with as much alum as it can dissolve, and a little gum, forms a good red ink. These processes consist in forming a lake, and retarding its precipitation by the gum. See LAKE.

On many occasions it is of importance to employ an ink indestructible by any process, that will not equally destroy the material on which it is applied. Mr. Close has recommended for this purpose 25 grains of copal in powder dissolved in 200 grains of oil of lavender, by the assistance of gentle heat, and then mixed with $2\frac{1}{2}$ grains of lamp black and half a grain of indigo: or 120 grains of oil of lavender, 17 grains of copal, and 60 grains of vermilion. A little oil of lavender, or of turpentine, may be added, if the ink be found too thick. Mr. Sheldrake suggests, that a mixture of genuine asphaltum dissolved in oil of turpentine, amber varnish, and lamp black, would be still superior.

When writing with common ink has been effaced by means of oxygenized muriatic acid, the vapour of sulphuret of ammonia, or immersion in water impregnated with this sulphuret, will render it again legible. Or if the paper that contained the writing be put into a weak solution of prussiate of potash, and when it is thoroughly wet a sulphuric acid be added to the liquor, so as to render it slightly acidulous, the same purpose will be answered.

Mr. Haussman has given some compositions for marking pieces of cotton or linen, previous to their being bleached, which are capable of resisting every operation in the processes both of bleaching and dying, and consequently might be employed in marking linen for domestic purposes. One of these consists of asphaltum dissolved in about four parts of oil of turpentine, and with this is to be mixed lamp black, or black lead in fine powder, so as to make an ink of a proper consistence for printing with types. Another, the blackish sulphate left after expelling oxygen gas from oxide of manganese with a moderate heat being dissolved and filtered, the dark grey pasty oxide left on the filter is to be mixed with a very little solution of gum tragacanth, and the cloth marked with this is to be dipped in a solution of potash or soda, mild or caustic, in about ten parts of water.

Among the amusing experiments of the art of chemistry, the exhibition of sympathetic inks holds a distinguished place. With these the writing is invisible, until some reagent gives it opacity. We shall here mention a few out of the great number, that a slight acquaintance with chemistry may suggest to the student. 1. If a weak infusion of galls be used, the writing will be invisible till the paper be moistened with a weak solution of sulphate of iron. It then becomes black, because these ingredients form ink. 2. If paper be soaked in a weak infusion of galls, and dried, a pen dipped in the solution of sulphate of iron will write black on that paper, but colourless on any other paper. 3. The diluted solutions of gold, silver, or mercury, remain colourless upon the paper, till exposed to the sun's light, which gives a dark colour to the oxides, and renders them visible. 4. Most of the acids or saline solutions being diluted, and used to write with, become visible by heating before the fire, which concentrates them, and assists their action on the paper. 5. Diluted prussiate of potash affords blue letters when wetted with the solution of sulphate of iron. 6. The solution of cobalt

in aqua-regia, when diluted, affords an ink which becomes green when held to the fire, but disappears again when suffered to cool. This has been used in fanciful drawings of trees, the green leaves of which appear when warm, and vanish again by cold. This effect has not been explained. If the heat be continued too long after the letters appear, it renders them permanent. 7. If oxide of cobalt be dissolved in acetous acid, and a little nitre added, the solution will exhibit a pale rose colour when heated, which disappears on cooling. 8. A solution of equal parts of sulphate of copper and muriate of ammonia gives a yellow colour when heated, that disappears when cold.

Sympathetic inks have been proposed as the instruments of secret correspondence. But they are of little use in this respect, because the properties change by a few days remaining on the paper; most of them have more or less of a tinge when thoroughly dry; and none of them resist the test of heating the paper till it begins to be scorched.

INNS *and innkeepers*. If one who keeps a common inn refuse either to receive a traveller as a guest into his house, or to find him victuals or lodging, upon his tendering a reasonable price for them, he is not only liable to render the damages for the injury in an action on the case, at the suit of the party grieved, but also may be indicted and fined at the suit of the king. In return for such responsibility, the law allows him to retain the horse of his guest until paid for his keep; but he cannot retain such horse for the bill of the owner, although he may retain his goods for such bill; neither can he detain one horse for the food of another. An innkeeper, however, is not bound to receive the horse unless the master lodge there also. Neither is a landlord bound to furnish provisions, unless paid beforehand. If an innkeeper make out unreasonable bills, he may be indicted for extortion; and if either he or any of his servants knowingly sell bad wine, or bad provisions, they will be responsible in an action of deceit. Keeping an inn is not a trading to make a man a bankrupt; but where an innkeeper is a chapman also, and buys and sells, he may on that account be a bankrupt. Innkeepers are clearly chargeable for the goods of guests stolen or lost out of their inns, and this without any contract or agreement for that purpose. But if a person come to an innkeeper, and desire to be entertained by him, which the innkeeper refuses, because, in fact, his house is already full; whereupon the party says he will shift among the rest of his guests, and there he is robbed, the host shall not be charged. If a man come to a common inn to harbour, and desire that his horse may be put to grass, and the host put him to grass accordingly, and the horse is stolen, the host shall not be charged; because by law the host is not bound to answer for any thing out of his inn, but only for those things that are *infra hospitium*. Innkeepers may detain the person of the guest who eats till payment. By the custom of London and Exeter, if a man commit an horse to an hostler, and he eat out the price of his head, the hostler may take him as his own, upon the reasonable appraisement of four of his neighbours; yet he cannot justify the taking him to himself at the price it was appraised at.

INNATE *ideas*, those supposed to be stamped on the mind from the first moment of its existence, and which it constantly brings into the world with it: a doctrine which Mr. Locke has abundantly refuted. See IDEA.

INNOMINATA *ossa*, in anatomy, three bones, which compose the extreme part of the trunk of a human body.

INNUENDO, is a word used in declarations and law pleadings, to ascertain a person or thing which was named before; as to say he (innuendo the plaintiff) did so and so, when there was mention before of another person. Innuendo may serve for an explanation, where there is precedent matter, but never for a new charge; it may apply what is already expressed, but cannot add or enlarge the importance of it. The doctrine of innuendoes is strangely misunderstood, in the opinion of the writer of this article, and has been confounded by too much learning and technical distinction being applied to it. The meaning of the word is 'limiting, suggesting, or meaning.' All words have different meanings, according to the manner, time, and other circumstances under which they are used. If the words are used in their plain sense they need no explanation; if in any other sense, then all the circumstances by which that sense is to be made out to be the meaning of the party must be stated, and then the pleader may suggest the true meaning in the indictment under an innuendo; but before the innuendo is used, the circumstances must be stated to which it applies. This is

the plain and simple clue to solve all the difficulties that have occurred upon the subject.

INOCARPUS, in botany, a genus of the Decandria Monogynia class and order. Natural order of Dumosæ. Sapotæ, Jussieu. Essential character: calyx bifid; corolla funnel-form; stamens in a double row; drupe one-seeded. There is but one species, *viz.* I. edulis, a native of the Society, Friendly, New Hebrides Isles, &c. in the South Seas; also in Amboyna.

INOCULATION, in medicine, the art of transplanting a distemper from one subject to another, by incision, particularly used for ingrafting the small-pox. See VACCINATION.

INOCULATION. See BUDDING.

INORDINATE *proportion*, is where there are three magnitudes in one rank, and three others proportional to them in another, and you compare them in a different order. Thus suppose the numbers in one rank to be 2, 3, 9; and those of the other rank 8, 24, 36; which are compared in a different order, *viz.* 2 : 3 :: 24 : 36; and 3 : 9 :: 8 : 24. Then rejecting the mean terms of each rank, you conclude 2 : 9 :: 8 : 36.

INQUEST, in law, an inquisition by jurors, or a jury, which is the most usual trial of all causes, both civil and criminal, within this realm.

INQUISITION, in law, a manner of proceeding by way of search and examination, and used in the king's behalf on temporal causes and process, in which sense it is confounded with office. This inquisition is upon an outlawry found, in case of treason and felony committed; upon a *felo de se*, &c. to entitle the king to a forfeiture of lands and goods; and there is no such nicety required in an inquisition as in pleading: because an inquisition is only to inform the court how process shall issue for the king, whose title accrues by the attainder, and not by the inquisition; and yet in cases of the king and a common person, inquisitions have been held void for uncertainty. Some of the inquisitions are in themselves convictions, and cannot afterwards be traversed or denied, and therefore the inquest ought to hear all that can be alledged on both sides. Of this nature are all inquisitions of *felo de se;* of flight, in persons accused of felony; of deodands, and the like; and presentment of petty offences in the sheriff's term, or court leet, whereupon the presiding officer may set a fine. Other inquisitions may be afterwards traversed and examined; as particularly the coroner's inquisition of the death of a man; for in such cases the offender may be arraigned upon the inquisition, and dispute the truth of it.

INROLLMENT, in law, is the registering, recording, or entering in the rolls of the Chancery, King's Bench, Common Pleas, or Exchequer, or by the clerk of the peace in the records of the quarter sessions, of any lawful act; a statute or recognizance acknowledged, a deed of bargain and sale of lands, and the like. But the inrolling a deed does not make it a record, though it thereby becomes a deed recorded; for there is a difference between a matter of record and a thing recorded to be kept in memory; a record being the entry in parchment of judicial matters controverted in a court of record, and whereof the court takes notice, whereas an inrollment of a deed is a private act of the parties concerned, of which the court takes no cognizance at the time of doing it, although the court permits it. By statute 27 Henry VIII. c. 16, no lands shall pass, whereby any estate of inheritance or freehold shall take effect, or any use thereof be made, by reason only of any bargain and sale thereof, except the bargain and sale be made by writing indented, sealed, and within six months inrolled in one of the king's courts of record at Westminster; or else within the county where the lands lie, before the clerk of the peace, and one or more justices. But by fifth Elizabeth, c. 26, in the counties palatine, they may be inrolled at the respective courts there, or at the assizes. Every deed before it is inrolled is to be acknowledged to be the deed of the party, before a master of chancery, or a judge of the court wherein it is inrolled, which is the officer's warrant for inrolling it; and the inrollment of a deed, if it be acknowledged by the grantor, it will be a good proof of the deed itself upon trial. But a deed may be inrolled without the examination of the party himself; for it is sufficient if oath be made of the execution. If two are parties, and the deed be acknowledged by one, the other is bound by it. And if a man live abroad, and would have lands here in England, a nominal person may be joined with him in the deed, who may acknowledge it here, and it will be binding. There have been plans proposed for the inrolling all conveyances of lands, and registering them, in order to secure men's titles; but this has been objected to by the landed interest in

parliament, chiefly from motives of delicacy.

INSCRIBED, in geometry. A figure is said to be inscribed in another, when all its angles touch the sides or planes of the other figure.

INSCRIPTION, a title or writing carved, engraved, or affixed to any thing, to give a more distinct knowledge of it, or to transmit some important truth to posterity. The inscriptions mentioned by Herodotus and Diodorus Siculus, sufficiently shew that this was the first method of conveying instruction to mankind, and transmitting the knowledge of history and sciences to posterity; thus the ancients engraved upon pillars both the principles of sciences, and the history of the world. Pisistratus carved precepts of husbandry on pillars of stone; and the treaties of confederacy between the Romans and Jews were engraved on plates of brass. Hence, antiquarians have been very curious in examining the inscriptions on ancient ruins, coins, medals, &c.

INSECTS, in natural history. We have, under the article ENTOMOLOGY, given an account of the Linnæan system of this department of natural history. We shall, in this place, enumerate some of those circumstances which form the line of distinction between insects and other animals. Insects are not furnished with red blood, but instead of it their vessels contain a transparent lymph. This may serve to distinguish them from the superior animals, but it is common to them with many of the inferior; though Cuvier has lately demonstrated the existence of a kind of red blood in some of the vermes. They are destitute of internal bones; but, in place of them, are furnished with a hard external covering, to which the muscles are attached, which serves them both for skin and bones; they are likewise without a spine formed of vertebræ, which is found in all the superior classes of animals. They are furnished with articulated legs, six or more; this circumstance distinguishes them from all other animals destitute of a spine formed of vertebræ. A very great number of insects undergo a metamorphosis: this takes place in all the winged insects. They frequently change their skin in the progress of their growth. A very great number of insects are furnished with jaws placed transversely.

The wings, with which a very great number of insects are furnished, distinguish them from all other animals which are not furnished with a spine composed of vertebræ. Insects are generally oviparous; scorpions and aphides, during the summer months, are viviparous. Insects have no nostrils, are destitute of voice: they are not furnished with a distinct heart, composed of ventricle and auricle. Incubation is not necessary for hatching their eggs. Insects, like all other organized bodies, which form the animal and vegetable kingdoms, are composed of fluids and solids. In the four superior classes of animals, *viz.* quadrupeds, birds, reptiles, and fishes, the bones form the most solid part, and occupy the interior part both of the trunk and limbs; they are surrounded with muscles, ligaments, cellular membrane, and skin. The matter is reversed in the class of insects; the exterior part is most solid, serving at the same time both for skin and bones; it encloses the muscles and internal organs, gives firmness to the whole body, and, by means of its articulations, the limbs, and different parts of the body, perform their various motions. In many insects, such as the crab, lobster, &c., the external covering is very hard, and destitute of organization; it is composed of a calcareous earth, mixed with a small quantity of gelatine, formed by an exudation from the surface of the body. As its great hardness would check the growth of the animal, nature has provided a remedy; all of these crustaceous insects cast their shell annually. See CRUSTS. The skin of most of the other insects is softer and organized, being formed of a number of thin membranes, adhering closely to one another, and putting on the appearance of horn. It owes its greater softness to a larger proportion of gelatine. The muscles of insects consist of fibres formed of fasciculi; there are commonly but two muscles to produce motion in any of their limbs, the one an extensor, the other a flexor. These muscles are commonly attached to a tendon, composed of a horny substance, connected to the part which they are destined to put in motion. In most insects, the brain is situated a little above the œsophagus; it divides into two large branches, which surround the œsophagus, and unite again under it, from which junction a whitish nervous cord proceeds, corresponding to the spinal marrow of the superior animals, which extends the whole length of the body, forming in its course twelve or thirteen knots or ganglions, from each of which small nerves proceed to different parts of the body. Whether insects be endowed with any senses different from

those of the superior animals, cannot easily be ascertained. It appears pretty evident, that they possess vision, hearing, smell, and touch; as to the sense of taste we are left to conjecture, for we are acquainted with no facts, by which we can prove that insects do or do not enjoy the sense of taste. The eyes of insects are of two kinds; the one compound, composed of lenses, large, and only two in number; the other are small, smooth, and vary in number from two to eight. The small lenses which form the compound eyes are very numerous; they amount, in some insects, to many hundreds. The far greater number of insects have only two eyes, but some have three, as the scolopendra; some four, as gyrinus; some six, as scorpions; some eight, as spiders. The eyes of insects are commonly immoveable; crabs, however, have the power of moving their eyes. That insects are endowed with the sense of hearing, can no longer be disputed, since frog-hoppers, crickets, &c. furnish us with undeniable proofs of the fact. Nature has provided the males of these insects with the means of calling their females, by an instrument fitted to produce a sound, which is heard by the latter. The male and female death-watch give notice of each others' presence, by repeatedly striking with their mandibles against old wood, &c. their favourite haunts. Their ears have been discovered to be placed at the root of their antennæ, and can be distinctly seen in some of the larger kinds, as the lobster. That insects enjoy the faculty of smelling, is very evident; it is the most perfect of all their senses. Beetles of various sorts, the different species of dermestes, flies, &c. perceive at a considerable distance the smell of ordure and dead bodies, and resort in swarms to the situations in which they occur, either for the purpose of procuring food, or laying their eggs. Insects feed on a great variety of substances; there are few things either in the vegetable or animal kingdoms which are not consumed by some of them. The leaves, flowers, fruit, and even the ligneous parts of vegetables afford nourishment to a very numerous class; animal bodies both dead and alive, even man himself, is preyed on by many of them; several species of the louse, of the acarus, of the gnat, and the common flea, draw their nourishment from the surface of his body; the pulex ulcerans penetrates the cuticle, and even enters his flesh. A species of gadfly, œstrus hominis, deposits its eggs under his skin, where the larvæ feed. Other caterpillars insinuate themselves into different cavities of his body. All the inferior animals have their peculiar parasitical insects, which feed on them during their life. There are some insects which can feed only on one species. The caterpillars, both of moths and butterflies, feed on the leaves of some particular vegetable, and, it is said, would die, could they not obtain this. There are others which can make use of two or three kinds of vegetables, but which never attain full perfection, except when they are fed on one particular kind; for example, the common silk-worm, which eats readily all the species of mulberry, and even common lettuce, neither attains so great a size, nor produces so much silk, as when fed on the white mulberry. There are a great many which feed indiscriminately on a variety of vegetables. Almost all herbivorous insects eat a great deal, and very frequently; and most of them perish, if deprived of food for but a short time. Carnivorous insects can live a long while without food, as the carabus, dytiscus, &c. As many insects cannot transport themselves easily in quest of food, to places at a distance from one another, nature has furnished the perfect insects of many species with an instinct, which leads them to deposit their eggs in situations where the larvæ, as soon as hatched, may find that kind of food which is best adapted to their nature. Most of the butterflies, though they flutter about, and collect the nectarious juice of a variety of flowers, as food for themselves, always deposit their eggs on or near to those vegetables destined by nature to become the food of their larvæ. The various species of ichneumon deposit their eggs on the bodies of those insects on which their larvæ feed. See Ichneumon. The sirex and sphex are likewise careful to deposit their eggs in situations where their larvæ, when hatched, may find subsistence. The sphex figulus deposits its eggs on the body of spiders, which it has killed, and encloses it in a cell composed of clay. Some insects, at different periods of their existence, make use of aliment of very different properties: the larvæ of some are carnivorous, while the perfect insect feeds on the nectareous juice of flowers: *e. g.* sirex, ichneumon, &c. The larvæ of most of the lepidopterous insects feed on the leaves and young shoots of vegetables, while the perfect insects either take no food at all, or subsist on the sweet juice which they extract from flowers: in-

deed the construction of their mouths prevents them from taking any other than fluid food.

We shall now refer to the functions of insects: beginning with respiration, which is the act of inhaling and exhaling the air into and out of the lungs. Quadrupeds, birds, and most of the amphibia, breathe through the mouth and nostrils. The air, when received into the lungs, is mixed with the blood, and imparts to it something necessary, and carries off something noxious. Some authors have asserted, that insects have no lungs; but later experiments and observations show, that no species wants them, or, at least, something similar to them; and in many insects they are larger in proportion to their bodies than in other animals. In most of them they lie at or near to the surface of the body, and send out lateral pores or tracheæ.

The respiration of insects has attracted the attention of many naturalists, and it is found, that insects do not breathe through the mouth or nostrils; that there are a number of vessels, for the reception of air, placed along on each side of the body, which are commonly called spiracula, which are subdivided into a number of smaller vessels, or bronchiæ; that the vessels, or tracheæ, which proceed from the pores on the sides, are not composed of a simple membrane, but are tubes formed of circular rugæ; that the spiracula are distinguishable, and are covered with a small scaly plate, with an opening in the middle like a button-hole, which is furnished with membranes, or threads, to prevent the admission of extraneous bodies.

Insects are the only animals without vertebræ, in which the sexes are distinguished. Copulation is performed in them by the introduction of the parts of generation of the male into those of the female. All insects are either male or female, except in a few of the genera of the order Hymenoptera, such as the bee, ant, &c. where individuals are to be found, which are neither male nor female; and, on that account called neuters. Among the bees, the neuters form the far greater part of the community, and perform the office of labourers. Among the ants, the neuters are very numerous, and constitute the only active members of the society. It has been alleged, that these neuters are nothing but females, whose parts have not been developed for want of proper nourishment. Olivier, however, after strict examination, is disposed to think them really different, though he does not adduce facts sufficient to establish his opinion. The parts which distinguish the male from the female, may be divided into two classes, *viz.* 1. Those which are not directly connected with generation. 2. Those which are absolutely necessary for the purposes of generation. The circumstances which have no direct communication with generation, which serve to point out the distinction between the sexes, are the difference of size observable in the male and female; the brightness of the colour in each; the form and number of articulations of the antennæ; the size and form of their wings; the presence or absence of a sting; the male is always smaller than the female; the female ant is nearly six times larger than the male; the female cochineal is from twelve to fifteen times the size of the male; the female termes is two hundred or three hundred times the size of the male; the colours of the male are commonly much more brilliant than those of the female; this is particularly the case in lepidopterous insects; in some insects, the colour of the male is totally different from that of the female; the antennæ of the male are commonly of a different form, and larger than those of the female; frequently the males are furnished with wings, while the females have none; the lampyris, coccus, and blatta, and several moths, afford an example of this; the female bee is furnished with a sting, while the male is destitute of one; the males of some insects are furnished with sharp prominent points, resembling horns, situated either on the head or breast, which are either not perceptible, or very faintly marked, in the female. The parts essential to generation afford the best distinguishing mark; in most insects they are situated near the extremity of the rectum; by pressing the abdomen near to the anus, they may frequently be made to protrude; but the parts of generation are not always situated near the anus: in the spiders, they are situated in the feelers; in the libellula, the male organ is situated in the breast, while that of the female is placed at the anus.

The eggs of insects are of two sorts: the first membranaceous, like the eggs of the tortoise, and the other reptiles; the other covered with a shell like those of the birds; their figure varies exceedingly; some are round, some elliptical, some lenticular, some cylindrical, some pyramidal, some flat, some square, but the round and oval are the most common. The eggs of insects sel-

dom increase in size, from the time they have been deposited by the parent, till they are hatched; those of the tenthredo, however, and of some others, are observed to increase in bulk. At first there is nothing to be perceived in the eggs of insects but a watery fluid; after some little time, an obscure point is observable in the centre, which, according to Swammerdam, is not the insect itself, but only its head, which first acquires consistence and colour: and the same author alleges, that insects do not increase in bulk in the egg, but that their parts only acquire shape and consistence. Under the shell of the egg, there is a thin and very delicate pellicle, in which the insect is enveloped, which may be compared to the chorion, and amnios, which surround the fœtus in quadrupeds. The little insect remains in the egg till the fluids are dissipated, and till its limbs have acquired strength to break the egg, and make its escape; the different species of insects remain inclosed in the egg for very different periods; some continue enclosed only a few days, others remain for several months. The eggs of many insects remain without being hatched during the whole winter, and the young insects do not come forth from them, till the season at which the leaves of the vegetables, on which they feed, begin to expand. When the insects are ready to break their prison, they commonly attempt to pierce the shell with their teeth, and form a circular hole, through which they put forth first one leg, and then another, till they extricate themselves entirely.

Insects are by far the most numerous class of animals: about eleven thousand species have been described by Gmelin, in the last edition of the "System of Nature:" a great many more have been described by other naturalists since the publication of that work; and a very considerable number are to be met with in the cabinets of the curious, which have not as yet been described by any author. In those parts of the world which we are best acquainted with, we may easily suppose that many species of insects exist, which have hitherto escaped notice. The minuteness of some insects makes them easily overlooked; the agility of others renders the catching of them difficult; the retired situations which many of them haunt, favour their concealment. In the unexplored parts of America, Africa, and Asia, many hundred species must exist utterly unknown to naturalists: all these circumstances render it very probable, that not one half of the insects which exist in the world have hitherto been described.

Insects afford nourishment to a great number of the superior animals: many of the fishes, reptiles, and birds, draw the principal part of their sustenance from that source. The immense swarms of different species of crab, which abound in every sea, directly or indirectly form the principal part of the food of the cod, haddock, herring, and a great variety of fishes. The snake, lizard, frog, and many other reptiles, feed both on land and aquatic insects. Gallinacious fowls, and many of the small birds, &c. feed on insects. Swallows, indeed, feed entirely on winged insects. They afford food, likewise, to many of the mammalia, *viz.* to many species of the bat, to the ant-eater, &c., and even to man himself. Many species of crab, *viz.* lobster, common crab, shrimp, prawn, land-crab, &c. are reckoned delicacies. The larvæ of some coleopterous insects and locusts form part of the food of man. Insects, likewise, by consuming decayed animal and vegetable matter, which, if left to undergo the putrefactive process, on the surface of the ground, might taint the atmosphere with pestilential vapours, preserve the air pure for the respiration of man and other animals.

INSERTION, in anatomy, the close conjunction of the vessels, tendons, fibres, and membranes of the body with some other parts.

INSOLATION, in chemistry, a term sometimes made use of to denote that exposure to the sun, which is made in order to promote the chemical action of one substance upon another: one of the most striking experiments of this kind is that of the exposure of vegetables, as fresh-gathered cabbage-leaves, in a glass jar of water, to the rays of the sun, by the action of which a large quantity of pure oxygen gas is obtained.

INSOLUBILITY, in chemistry. The insolubility of a substance in a fluid, which is the medium of chemical action, has an influence on that action somewhat similar to that of cohesion, and is nothing but a modification of it, in relation to the fluid in which it is exerted. If substances in their liquid state be made to act on each other, their action will meet with little foreign resistance, and will be, in a great measure, proportioned to their affinity and quantity; but if one of them be solid, and be farther insoluble in the fluid, which is the medium of

action, the insoluble matter must present comparatively few points of contact; it must be always withdrawn from the sphere of action, and of course, if it be opposed to a combination, it can act with comparatively little energy. From the same cause, if it be a compound, and be acted on by any substance tending to combine with one of its principles, its insolubility must in some measure protect it, as abstracting it from the action of the decomposing substance.

INSOLVENT *debtors.* Insolvent acts are statutes passed for the purpose of releasing from prison, and sometimes from their debts, persons whose transactions have not been of such a nature as would subject them to the bankrupt laws. Their discharge is usually from all suits and imprisonment, upon delivering up all their estates and effects, real and personal, for the benefit of their creditors.

INSPIRATION, among divines, &c. implies the conveying of certain extraordinary and supernatural notices or motions into the mind; or it denotes any supernatural influence of God upon the mind of a rational creature, whereby he is formed to any degree of intellectual improvements, to which he could not, or would not, in fact, have attained in his present circumstances, in a natural way. Thus the prophets are said to have spoken by divine inspiration.

Some authors reduce the inspiration of the sacred writers to a particular care of Providence, which prevented any thing they had said from failing or coming to nought; maintaining, that they never were really inspired either with knowledge or expression. According to others, inspiration is no more than a direction of the Holy Spirit, which never permitted the sacred writers to be mistaken. It is a common opinion, that the inspiration of the Holy Spirit regards only the matter, not the style or words.

Theological writers have enumerated several kinds of inspiration; such as "an inspiration of superintendency," in which God does so influence and direct the mind of any person, as to keep him more secure from error in some various and complex discourse, than he would have been merely by the use of his natural faculties; "plenary superintendent inspiration," which excludes any mixture of error from the performance so superintended; "inspiration of elevation," where the faculties act in a regular, and, as it seems, in a common manner, yet are raised to an extraordinary degree, so that the composure shall, upon the whole, have more of the true sublime or pathetic, than natural genius could have given; and "inspiration of suggestion," when the use of the faculties is superseded, and God does, as it were, speak directly to the mind, making such discoveries to it, as it could not otherwise have obtained, and dictating the very words in which such discoveries are to be communicated, if they are designed as a message to others.

It is generally allowed, that the New Testament was written by a superintendent inspiration; for without this the discourses and doctrines of Christ could not have been faithfully recorded by the Evangelists and Apostles; nor could they have assumed the authority of speaking the words of Christ, and evinced this authority by the actual exercise of miraculous powers: and besides, the sacred writings bear many obvious internal marks of their divine original, in the excellence of their doctrines, the spirituality and elevation of their design, the majesty and simplicity of their style, the agreement of their various parts, and their efficacy on mankind; to which may be added, that there has been in the Christian church, from its earliest ages, a constant tradition, that the sacred books were written by the extraordinary assistance of the Spirit, which must at least amount to superintendent inspiration; but it has been controverted, whether this inspiration extended to every minute circumstance in their writings, so as to be in the most absolute sense plenary. Jerome, Grotius, Erasmus, Episcopius, and many others, maintain that it was not; whilst others contend, that the emphatical manner in which our Lord speaks of the agency of the Spirit upon them, and in which they themselves speak of their own writings, will justify our believing, that their inspiration was plenary, unless there be very convincing evidence brought on the other side to prove that it was not: and if we allow, it is said, that there were some errors in the New Testament, as it came from the hands of the Apostles, there may be great danger of subverting the main purpose and design of it; since there will be endless room to debate the importance both of facts and doctrines. See Doddridge's Lectures.

INSTALMENT, the instating or establishing a person in some dignity. This word is chiefly used for the induction of a dean, prebendary, or other ecclesiastical

dignitary, into the possession of his stall, or other proper seat, in the cathedral to which he belongs. It is also used for the ceremony whereby the knights of the garter are placed in their rank, in the chapel of St. George at Windsor, and on many other like occasions. It is sometimes termed installation.

INSTANT, such a part of duration wherein we perceive no succession; or it is that which takes up the time only of one idea in our minds.

INSTINCT, an appellation given to the sagacity and natural inclinations of brutes, which supplies the place of reason in mankind.

INSTITUTES, in literary history, a book containing the elements of the Roman law, and constitutes the last part of the civil law. The Institutes are divided into four books, and contain an abridgment of the whole body of the civil law, being designed for the use of students.

INSTITUTION, to a benefice, is that whereby the ordinary commits the cure of souls to the parson presented, as by induction he obtains a temporal right to the profits of the living. Previous to the institution, the oath against simony, the oaths of allegiance and supremacy, are to be taken; and if it be a vicarage, the oath of residence. They are also to subscribe the thirty-nine articles, and the articles concerning the king's supremacy, and the book of common prayer.

INSULATED, in electricity, a term applied to bodies that are supported by electrics, or non-conductors, so that their communication with the earth, by conducting substances, is interrupted.

INSURANCE, or ASSURANCE, in law and commerce, a contract or agreement whereby one or more persons, called insurers, assurers, &c. oblige themselves to answer for the loss of a ship, house, goods, &c. in consideration of a premium paid by the proprietors of the things insured. See ASSURANCE.

INSURANCE, *marine*. Insurance is a contract of indemnity, whereby the party, in consideration of a stipulated sum, undertakes to indemnify the other against certain specific perils or risks to which he is exposed, or against the occurrence of such events. The party who takes on himself the risk, is called the insurer; the party protected by the insurance is called the insured; the sum paid to the insurer as the price of this risk, is called the premium; and the written instrument, in which the contract is set forth, and reduced into form, is called a policy of insurance.

Marine insurance is made for the protection of persons having an interest in ships or goods on board, from the loss or damage which may happen from the perils of the sea, during a certain voyage, or for a fixed period of time.

In this country all persons, whether British subjects or aliens, may in general be insured; the only exception is in the case of an alien enemy. He cannot maintain an action on a policy on goods, though they were shipped before the war commenced; nor can an agent of such insured maintain the action, though he be a creditor of the insured for more than the sum insured.

The statute, 6 George I. c. 18, authorised the king to grant charters to two distinct companies or corporations, called the Royal Exchange Assurance, and London Assurance; for the insurance of ships, goods, and merchandises at sea, or going to sea, and for lending money on bottomry. They are invested with all the powers usually granted to corporations, and the privilege of purchasing lands to the amount of one thousand pounds per annum each, to provide a sufficient capital to insure all demands on their policies. All other companies are restrained from insuring ships and goods at sea, or lending money on bottomry. And all policies made by any other corporation, and any copartnerships, shall be void, and the sums underwritten forfeited, and all bottomry bonds deemed usurious; but the right of individual insurers continues as before the act. Contracts made in derogation of the rights of the insurance companies, are illegal and void.

Ships, freight, goods, and merchandises, &c. are the proper subjects of marine insurance, and there are certain articles which from motives of public policy cannot be legally insured in this country, and others which can only be insured under particular restrictions.

Insurance being a contract of indemnity from loss or damage, arising upon an uncertain event, there cannot be an indemnity without a loss, nor a loss without an interest; a policy therefore, without interest, is not an insurance, but a mere wager. Different persons, having each a qualified property in goods, may insure them to the full value. A reasonable expectation of profit, on a well founded expectation of a future

interest in the thing insured, is an insurable interest.

Wager policy. This is usually conceived in the terms, interest or no interest, or, without further proof of interest than the policy, to preclude all inquiry into the interest of the insured, and as a consequence of the insured's having no interest in the pretended subject of the policy, it follows, that the insurer cannot be liable for any partial loss.

Insurance *Re.* A policy of insurance being once signed, the underwriters are bound by the terms of it, nor can they be released from their contract without the consent of the insured. But an underwriter may shift it, or part of it from himself to other insurers, by causing a re-insurance to be made on the same risk, and the new insurers will be responsible to him in case of loss, to the amount of the re-insurance. But the re-insurer is only responsible to the original insurer, and not to the original insured. Thus stands the law on this subject in most of the states of Europe; but in England, by the 19 George II. c. 37, re-insurances are prohibited, except in case of the insolvency or death of the original insurer. This has been held to extend not only to British, but also to foreign ships.

Insurance, *double,* is where the insured make two insurances on the same risk and the same interest. A double insurance, though it be made with a view to a double satisfaction in case of loss, and is therefore in the nature of a wager, is not void. The two policies are considered as making but one insurance, and are good to the extent of the value of the effects put in risk. All the underwriters in this case contribute in proportion to their several subscriptions; and therefore, if the insured should sue only on one of the policies, the under-writers on that policy may recover a ratable contribution from those on the other.

Of the voyage. No insurance can be legally made upon any voyage undertaken contrary to the laws of this kingdom, or to those of its dependencies, or to the law of nations, and it is immaterial whether the insurer was or was not informed that the voyage was illegal. An insurance, therefore, upon a voyage undertaken contrary to the navigation law, is void.

Insurances, *risks against which may be made.* Insurances may be made against all the risks or perils which are incident to sea voyages, subject, however, to certain exceptions founded in public policy and the interests of humanity, which require, that in certain cases men shall not be permitted to protect themselves against some particular perils of insurance. But an insurer cannot make himself answerable for a loss, proceeding from the fault of the insured. No insurance can be made, even against the perils of the sea, upon illegal commerce. In order to confine insurances against real and important losses arising from the perils of the sea, and to obviate disputes respecting losses from the perishable quality of the goods insured, and all trivial subjects of litigation, it appears to be the general law of all states, that the insurer shall not be liable for any average loss, unless it exceed one per cent. beside which a clause has been introduced into policies, that the insurer shall not be liable for any partial loss under a given rate per cent. In England it is now constantly stipulated in all policies, that upon certain enumerated articles the insurer shall not be answerable for any partial loss whatever; that upon certain others, liable to partial injuries, but less difficult to be preserved at sea, he shall only be liable for partial losses above three per cent. But this does not extend to the losses, however small, called general average, and losses occasioned by the stranding of the ship, and the loss by stranding must be an immediate loss.

Commencement and continuance of the risk. In England the commencement of the risk of the ship varies in almost every case. In outward-bound voyages, it is generally made to commence from her beginning to load at her port of departure. Sometimes privateers on a cruise, ships engaged in the coasting trade, or in short voyages, are insured for a limited period of time; and in such case the risk commences and ends with the term, wherever the ship may then happen to be. If a ship is insured from the port of London to any other port, and before she breaks ground an accident happens to her, the insurers are not answerable, for the risk does not commence till she sets sail on her departure from the port of London. But if the insurance be allowed, and from the port of London, the insurers are liable to any accident that may happen to her from the time of subscribing the policy. When a ship, expected to arrive at a certain place abroad, is insured at and from that place, or from her arrival there; the risk begins from the first moment of her arrival at the place specified, and the words first arrival are implied, and always under-

stood, in policies so worded. The risk in such cases continues there as long as the ship is preparing for the voyage insured; but if all thought of the voyage be laid aside, and the ship be suffered to lay there for a length of time with the owner's privity, the insurers are not liable. In English policies, it is usually made to continue only until the ship has moored at anchor twenty-four hours in good safety, and on such policies the insurer is liable for no loss after that time.

To charge the insurer it is not enough that a loss has happened at sea, it must appear to have happened in the course of the voyage, and during the continuance of the risk insured. Upon goods, the risk does not commence until they are actually on board the ship, and therefore the insurer is not answerable for any loss or damage which may happen to them while they are on the passage to the ship, and, in general, the risk on goods continues no longer than while they are on board the ship mentioned in the policy, and that if they be removed from on board that ship and landed, or put on board another ship without the consent of the insurers, the contract is at an end.

Policies, with reference to the reality of the interest of the insured, are distinguished into interest and wager policies; with reference to the amount of the interest, they are distinguished into open and valued. An interest policy is where the insured has a real, substantial, assignable interest in the thing insured, in which case only it is a contract of indemnity. A wager policy is a pretended insurance, where the insured has no interest in the thing insured. Insurances of this sort are usually expressed by the words interest or no interest, or without further proof of interest than the policy, or without benefit of salvage to the insurer, and these are wholly illegal. An open policy is where the amount of the insured is not fixed by the policy, but is left to be ascertained by the insured in case a loss should happen. A valued policy is where a value has been set on the ship or goods insured, and the value is inserted in the policy in the nature of liquidated damages, to save the necessity of proving it in case of total loss.

Every fact and circumstance relating to the contract of insurance, must be stated with the most scrupulous regard to truth. The voyage insured must, therefore, be truly and accurately described in the policy; namely, the time and place at which the risk is to begin, the place of the ship's departure, the place of her destination, and the time when the risk shall end; whether on goods or on the ship. If a blank be left for the place either of the ship's departure or destination, the policy will be void for the uncertainty.

A warrantry is a stipulation or agreement on the part of the insured, in nature of a condition precedent, or thing absolutely and strictly to be performed, as the very basis of the contract, as that the thing insured is neutral property, that the ship is of such a force, that she sailed, or was well on such a day, &c.; or as that a ship shall sail on or before some given day, that she shall depart with convoy, that she shall be manned with such a complement of men, &c. These warranties are either express or implied.

An implied warrantry is that which reasonably results from the nature of the contract, as that the ship shall be sea-worthy when she sails on the voyage insured, that the voyage is lawful, and shall be performed according to law, and in the usual course, and without deviation.

There are five things essential to a sailing with convoy: 1. It must be with the regular convoy appointed by government. 2. It must be from the place of rendezvous appointed by government. 3. It must be a convoy for the voyage. 4. The ship insured must have sailing instructions. 5. She must depart and continue with the convoy till the end of the voyage, unless separated by necessity.

Neutral property, in the sense of which that expression must be understood in this warrantry, is that which belongs to the subjects of a state in amity with the belligerent powers. The documents requisite for neutral ships are: 1. The passport. 2. The sea-letter, or sea-brief. 3. The proofs of property, which ought to show that the ship really belongs to the subjects of a neutral state. 4. The muster-roll. 5. The charter-party. 6. The bill of lading. 7. The invoices. 8. The log-book, or ship's journal. 9. The bill of health. But though the want of some of these papers may be taken as strong presumptive evidence, yet it is not conclusive evidence against the ship's neutrality.

Representations. A representation in an insurance is denoted to be a collateral statement, either by word of mouth, or in writing, of such facts or circumstances relative to the proposed adventure, and not inserted in the policy, as are necessary for

the information of the insurer, to enable him to form a just estimate of the risk.

A misrepresentation in a material point avoids the contract; and the insured cannot recover on the policy for loss arising from a cause unconnected with the fact misrepresented. So if it be made without knowing whether it be true or false, or even if the person making it believe it to be true; but if he only give it as his belief, without knowing the contrary, it will not affect the contract. Concealment consists in a fraudulent suppression of any fact or circumstance material to the risk. This, like every other fraud, avoids the contract *ab initio*, upon principles of natural justice. But it is not merely on the ground of fraud that a concealment avoids the contract; even an innocent concealment of material facts will avoid the policy.

Sea-worthiness. In every insurance, whether of ship or goods, there is an implied warrantry of the sea-worthiness of the ship, that is to say, that she shall be tight, staunch, and strong, properly manned, and provided with all necessary stores, and in every other respect fit for the voyage.

Deviation, is a voluntary departure, without reasonable cause, from the regular course of the voyage insured. From the moment this happens the contract becomes void. The course of the voyage does not mean the nearest possible way, but the usual and regular course. Accordingly stopping at certain places on the voyage is no deviation, if it be customary so to do; but such usage can only be supported by long and regular practice.

Loss, is either total or partial. The term total loss means not only the total destruction of, but also such damage to the thing insured, as renders it of little or no value to the insured, although it may specifically remain. Thus, a loss is said to be total, if, in consequence of the misfortune that has happened, the voyage be lost or not worth pursuing, and the projected adventure frustrated; or if the value of what is saved be less than the freight, &c. A partial loss is any thing short of a total loss; such losses are sometimes styled average losses. Losses by perils of the sea are generally understood to be such accidents or misfortunes as proceed from sea damage; that is to say, such as arise from stress of weather, winds, waves, lightning, tempests, rocks, sands, &c.

If a ship be not heard of for a reasonable time, she shall be presumed to have foundered at sea, and the insured has a right to recover as such, from the underwriter. A loss by fire, which is merely accidental, and not imputable to the master or mariners, is undoubtedly within the policy. If a ship be burnt by order of the state where she happens to be, to prevent infection, this also has been held a loss within the policy.

If a ship be attacked by an enemy, and the captain, unable to defend her, leave and set fire to her to prevent her from falling into the enemy's hands, the insurer is said to be liable.

Capture is where a ship is taken by an enemy in war, or by way of reprisals, or by a pirate. Capture may be with an intent to possess the ship and cargo, or only to seize the goods on board as contraband; the former is a capture, the latter only an arrest or detention. Every capture, whether lawful or unlawful, is within the policy; provided the words of the policy be sufficiently comprehensive. Where the ship is re-captured before abandonment, it is a partial loss; and the insurer is bound to pay the salvage, and other necessary expenses the insured may have incurred to recover his property. In general, wherever a ship is taken by the enemy, the insured may abandon and demand as for a total loss; but he is not bound to abandon; if he do, the insurer, in case of re-capture, will stand in his place, and is liable for all fair charges occasioned by the capture.

Loss by detention of princes, &c. There is an obvious difference between this and capture; the object of the one is prize, that of the other detention, with a design to restore the ship or goods detained, or pay the value to the owner: and though neither of these should be done, still it must be considered as the arrest of princes, the character of any action depending on the original design with which it was done. An arrest of princes may be at sea as well as in port, if it done from public necessity, and not with a view to plunder.

Loss by barratry. Barratry is any species of fraud committed by the master or mariners, whereby the owners sustain an injury; as by running away with the ship, wilfully carrying her out of her course, sinking or deserting her, embezzling the cargo, smuggling, or any other offence whereby the ship or cargo may be subjected to arrest, detention, loss, or forfeiture. No fault of the master or mariners amounts to barratry, unless it proceed from an intention to defraud the owners; therefore a deviation, if

made through ignorance, unskilfulness, or any motive which is not fraudulent, although it will avoid the policy, does not amount to barratry.

Loss by average contributions. The goods on board are in proportion to their respective interests, liable to contribute towards any particular loss or expense incurred for the general safety of the ship or cargo, so that the particular loser may not be a greater sufferer than the other owners of the goods. Thus, where the goods of a particular merchant are thrown overboard to lighten the ship; where the masts, cables, anchors, or other furniture of the ship are cut away, or destroyed, for the safety of the whole; in these, and similar cases, the loss is the proper subject of a general contribution, and ought to be rateably borne by the owners of the ship, freight, and cargo, so that the loss may fall proportionably on all. As to the articles liable to contribute, the rule is, that the ship, freight, and every thing remaining of the cargo, is subject to this charge; therefore, money, plate, and jewels, are as much liable as more heavy and bulky goods. But the persons on board, their wearing apparel, and the jewels belonging to it, shall not contribute; neither are seamen's wages liable to contribute.

Loss by expense of salvage. At common law, the party has a lien, on every thing saved, till payment of salvage; but the regulations now principally in force are ascertained by the statutes 12 Anne, c. 18, 26. Geo. II. c. 19, 33. Geo. III. c. 66. The insured need not in his action declare for salvage, but may recover under a declaration for the loss which occasioned it, and the damage which the goods have sustained. In case of neutral ships captured by the enemy, and retaken by British men-of-war, or privateers, the Court of Admiralty has a discretionary power of adjusting the salvage. Before an action will lie for a loss by payment of salvage, the amount must be ascertained by decision of the Court of Admiralty.

Abandonment. The insured may abandon in every case where, in consequence of any of the perils insured against, the voyage is lost, or not worth pursuing; where the thing insured is so damaged as to be of little or no value to the owner, where the salvage is immoderate, where what is saved is of less value than the freight, or where further expense is necessary, and the insurer will not undertake to pay that expense, &c.

Shipwreck is generally a total loss. What may be saved of the ship or cargo is so uncertain that the law cannot distinguish this from the loss of the whole. But a mere stranding of the ship is not of itself a total loss; it is only where the stranding is followed by shipwreck, or the ship is otherwise incapable of prosecuting her voyage.

Return of premium. The premium is to be returned in all cases where the contract is void for want of interest; which may be either total, as where the insured has nothing on board the ship, or partial, where he has some interest, but not to the amount in the policy; and it is a general rule, that wherever insurance is made through mistake, misinformation, or other innocent cause, without interest, or for more than the real interest, there shall be a return of premium.

On a wager policy, the insured cannot recover back the premium, at least after the risk is run. This policy is void, as being without interest, but both parties being guilty of a breach of the statute 19 Geo. II. c. 37, the rule, that where both parties are equally criminal the possessor has the advantage, applies, and the insured cannot recover back the premium.

INSURANCE *upon life*, is a contract, by which the underwriter for a certain sum, proportioned to the age, health, and profession of the person whose life is the object of the insurance, engages that the person shall not die within the time limited in the policy; or, if he do, that he, the underwriter, will pay a sum of money to the person in whose favour the policy is granted: and in this, as well as in marine insurances, the party must have an actual interest.

INSURANCE *against fire*, is a contract by which the insurer undertakes, in consideration of a premium, to indemnify the insured against all losses which he may sustain in his house or goods by means of fire, within the time limited in the policy.

INTEGER, in arithmetic, a whole number, in contradistinction to a fraction.

INTEGRAL, or *integrant*, in philosophy, appellations given to parts of bodies which are of a similar nature with the whole: thus filings of iron have the same nature and properties as bars of iron.

INTEGRAL *calculus*. See CALCULUS.

INTEGUMENTS, in physiology, denote the common coverings which invest the body, as the cutis, &c. The common integuments are the skin, with the fat and cel-

lular membrane adhering to it. The term integument is also extended to the particular membranes which invest certain parts of the body, as the coats or tunics of the eye.

INTELLIGENCE, in a military sense, may be variously applied, and of course has different significations. No general can be said to be in any degree qualified for the important situation which he holds, unless, like an able minister of state, he be constantly prepared with the requisite means to obtain the best intelligence respecting the movements and the designs of the enemy he is to oppose. On the other hand, it is not possible to conceive a greater crime than that of affording intelligence to an enemy, and thereby bringing about the overthrow and destruction of a whole army. A French military writer makes the following observations respecting the latter species of intelligence, which he classes under two specific heads. He justly remarks, that to hold correspondence, or to be in intelligence with an enemy, is not only to betray your king, but likewise your country. Armies and fortified places are almost always surprised and taken by means of a secret intelligence which the enemy keeps up with domestic traitors, acting in conjunction with commissioned spies and delegated hirelings.

A garrison town may be taken by surprise, under the influence of secret intelligence, in two different ways. The one is when the assailant, to whom the place has been surrendered, is not bound to join his forces to those troops by whom he has been admitted; the other, when it is necessary that an assault should be made by openly storming, by throwing shells and by petards, or by stratagem. The first species of intelligence may be held with a governor who has influence enough to direct the will and actions of the garrison; with a garrison which is indisposed towards the governor and the officers that command the troops; with the inhabitants who have undertaken to defend a place where no garrison is stationed; and, lastly, with the prevailing faction, where there are two parties that govern in a free town. The other species of intelligence may be practised with a governor who either wants power, or is afraid to tamper with the fidelity of the garrison; with some particular officer, serjeants, or soldiers; with the body of inhabitants, who think differently from the armed force that overawes them; or with active and shrewd individuals, who have access to the ruling party, and can skilfully combine affected loyalty with secret disaffection.

There is not, however, in human nature perhaps a more insidious, or a more dangerous ground to tread on, than that of secret intelligence; nor are the faculties of the mind ever so much put to the test as when it is necessary to listen to the report of an individual, who, whilst he is betraying one side, may be equally disposed to dupe the other. A wise general will consequently hear every thing, and say nothing; and a wise man, let his secret wishes be what they may, will warily consider, whether the person who insinuates to him even the possibility of a plot, does not at that instant endeavour to get into his confidence for the sole purpose of acting contrary to his supposed views, and of betraying the man who has unfolded other schemes. It is certainly justifiable policy, either in the governor of a town, or in a general, to affect to give into the views of any man or party of men whom he has cause to suspect, and whose ultimate object he is determined to defeat. But he should be equally cautious how he listens to the communications of spies or informers. The veil of honesty is often assumed to cover a deep-laid scheme of villainy; and apparent candour is the surest path to unguarded confidence. When villains voluntarily unfold themselves in such a manner as to convince an able and penetrating officer that their treachery can be depended upon, much blood may be spared by making a proper use of their intelligence. This axiom has prevailed in every civilized country; and should be well attended to by thinking men. For when a battle has been gained, it avails little to ask whether the enemy owed his success to force or treachery? No treachery, however, is admissible, or should be sanctioned by belligerent powers, which militates against those laws of nations which are founded upon the wise basis of humanity. Private assassination, the use of poison, or the disregard of paroles of honour, must be generally reprobated; and whatever general obtains his ends by any of these dark means, his name should be stamped with infamy, and he himself be exposed to all the melancholy casualties of retaliation. See James's Military Dictionary.

INTENSITY, in physics, is the degree or rate of power or energy of any quality, as of heat and cold. The intensity of qualities, as gravity, light, heat, &c. vary in the reciprocal ratio of the squares of the dis-

tances from the centre of the radiating quality.

INTERCALARY, in chronology, an appellation given to the odd day inserted in leap-year; which was so called from *calo*, *calare*, to proclaim, it being proclaimed by the priests with a loud voice. See BISSEXTILE.

INTERCEPTED *axis*, in conic sections, the same with abscisse. See ABSCISSE.

INTERDICT, an ecclesiastical censure, by which the Church of Rome forbids the performance of divine service in a kingdom, province, town, &c. This censure has been frequently executed in France, Italy, and Germany; and in the year 1170, Pope Alexander III. put all England under an interdict, forbidding the clergy to perform any part of divine service, except baptizing of infants, taking confessions, and giving absolution to dying penitents. But this censure being liable to the ill consequences of promoting libertinism and a neglect of religion, the succeeding popes have very seldom made use of it.

INTEREST, an allowance or compensation for the loan or use of a sum of money for a certain time, according to a fixed rate or proportion. The rate of interest varies in different countries, and at different times, according to the scarcity or plenty of money, and the security of lending; in most commercial states it has been thought necessary to establish by law a fixed rate of interest for the use of money: this restriction, however, must nearly correspond with the current rate of interest, that is, the rate at which money can be readily borrowed on good security; for if it be attempted to reduce by law the common rate of interest below the lowest ordinary market rate, the restriction will be generally evaded, as under all such attempts it has hitherto invariably been.

By 37th Henry VIII. cap. 9, all interest above 10 per cent. was declared unlawful: before that time higher rates had usually been taken. In the reign of Edward VI. religious zeal prohibited all interest for money; but the prohibition, like all others of the same kind, is said to have produced no effect, and probably rather increased than diminished the evil of usury. The statute of Henry VIII. was revived by the 13th Elizabeth, cap. 8, and 10 per cent. continued to be the legal rate of interest till the 21st of James I. when it was restricted to 8 per cent. In 1651, the rate of interest in several other countries being lower than in England, the parliament reduced the legal rate to 6 per cent. which soon after the restoration was confirmed by 12th Charles II. c. 13. The last act of parliament for regulating the interest of money was 12th Anne, st. 2. c. 16, by which it was fixed at 5 per cent. per annum. These different statutary regulations seem to have been made with great propriety, as they followed the market rate of interest; and since the time of Queen Anne, 5 per cent. appears to have been rather above than below the market rate. Before the American war, government borrowed at little more than 3 per cent.; and about the year 1792 good bills were readily discounted at 4 per cent.

The legal rate of interest in France was not always regulated by the market rate. In 1601 Henry IV. issued an edict for reducing the interest of money in that kingdom to $6\frac{1}{4}$ per cent.; but the current rate afterwards rose above this limit. In 1720 interest was reduced from the twentieth to the fiftieth penny, or from 5 to 2 per cent. In 1724 it was raised to the thirtieth penny, or to $3\frac{1}{3}$ per cent. In 1725 it was again raised to the twentieth penny, or to 5 per cent. In 1766 it was reduced to the twenty-fifth penny, or to 4 per cent; but a few years after it was raised again to the old rate of 5 per cent. The supposed purpose of many of these violent reductions of interest was to prepare the way for reducing that of the public debts; a measure which, when it is not justified by a previous fall in the current rate of interest is nothing better than defrauding the public creditors.

In Holland, previously to the revolution, the government frequently borrowed at 2 per cent., and private persons of good credit at 3 per cent. This lowness of interest induced many of the Dutch to invest their property in the French and English funds. In the United States of America the lawful rate of interest is 6 per cent. in most of the states; in a few it is 7 per cent.; and in one it is only 5 per cent. In Greece the mean rate of interest is 20 per cent. and in the other parts of Turkey nearly the same; in Persia 25 per cent.; and in the Mogul empire 30 per cent. In Bengal and the other British possessions in India, the interest is generally from 8 to 12 per cent. on government security, but individuals are frequently obliged to pay a much higher rate. In these countries there is no fixed rate of interest, and the usual high rate arises chiefly from the insecurity of lending.

Interest is generally payable yearly, half-

yearly, or quarterly, and is distinguished into *simple interest* and *compound interest*; the former being merely the compensation paid for the use of a capital, at a certain fixed rate for a year, and a proportionately greater or less sum for a greater or less time; while in the latter the interest which becomes due in the first year, or other interval, is added to the principal, and thus forms a new capital on which the interest of the second year is to be computed; and thus the capital, and consequently the amount of interest, are continually increasing. Simple interest only is lawful in loans between individuals, and in discounting notes or bills of exchange; but in the granting or purchasing of annuities, either for terms of years or for lives, or of leases, or reversions, it is usual to allow the purchaser compound interest for his money, unless there is a particular agreement to the contrary.

INTEREST, *simple.* If 5*l.* is the interest of 100*l.* for a year, $\frac{5}{100}$, or .05, is the interest of 1*l.* for the same term: for, as $100 : 5 :: 1 : \frac{5}{100}$. Let then the interest of 1*l.* for one year $= r$; the principal $= p$; the time $= t$; the amount in the said time, *viz.* principal and interest $= a$. Then r being the interest of 1*l.* for one year, the interest of 1*l.* for two years will be $2r$; for three years, $3r$; and for any number of years, tr. Now as one pound is to its interest, so is any given principal to its interest, or

As $1 : tr :: p : ptr =$ interest of p.

Then the principal being added to its interest, their sum will be $= a$, the amount required; which gives the following theorems for answering all questions relating to simple interest, *viz.*

If principal, time, and rate, are given to find the amount.

Theo. 1. $ptr + p = a.$

If the amount, time, and rate are given, to find the principal?

Theo. 2. $\frac{a}{tr + 1} = p$

If the principal, amount, and time, are given to find the rate?

Theo. 3. $\frac{a - p}{pt} = r$

If the principal, amount, and rate, are given to find the time?

Theo. 4. $\frac{a - p}{pr} = t$

Ex. 1. What sum will one penny amount to in 1808 years, if put out to interest at 5 per cent. per annum?

Multiply .004166 by 1808 and by .05, the product is .376666, which added to the principal, gives .380833 = 7*s.* $7\frac{1}{4}$*d.*

Ex. 2. What sum will amount to 100*l.* in seven years, at 4 per cent. per annum?

Multiply 7 by .04 and add 1, which makes 1.28; divide 100*l.* by this sum, and the quotient is 78.125 = 78*l.* 2*s.* 6*d.*

Ex. 3. At what rate per cent. per annum, will 100*l.* amount to 145*l.* 10*s.* in 7 years, at simple interest?

Subtract 100*l.* from 145*l.* 10*s.* the remainder is 45*l.* 10*s.* which divided by the product of the principal and time, or 700, gives .065 = $6\frac{1}{2}$ per cent.

Ex. 4. In what time will 125*l.* amount to 212*l.* 10*s.* at simple interest of 5 per cent. per annum?

Subtract 125*l.* from 212*l.* 10*s.* the remainder is 87*l.* 10*s.* which divided by the product of the principal and rate, or 6.25 gives the answer 14 years.

Tables of simple interest are easily computed, and many such have been published, but those only are of much utility which shew readily the interest of any sum for any number of days. Such a table is unavoidably very extensive, and forms of itself a thick volume; it cannot therefore be inserted in a work of this nature, but that which follows will answer all useful purposes to those who are acquainted with decimal arithmetic. Such as prefer a table expressed in pounds, shillings, and pence, are referred to the interest tables published by Mr. John Thomson of Edinburgh, Mr. Joseph King of Liverpool, and particularly to the improved interest tables of Mr. William Reed, which shew at one reference the interest at 5 per cent. of all sums at the dates that usually occur in business.

The interest of any sum for one day, is found by dividing the annual interest by 365; thus, at 5 per cent. the interest of 1*l.* for one day is........................ .00013699
which multiplied by 2 gives the
interest for 2 days....................... .00027397
by 3............3 days.......... .00041096
by 4............4................ .00054795
and by proceeding in this manner, the following table is easily formed.

TABLE,

Shewing the Simple Interest of One Pound for any Number of Days, at 5 per Cent. per Annum.

Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.
1	.0001369	27	.0036986	53	.0072602	78	.0106849
2	.0002739	28	.0038356	54	.0073972	79	.0108219
3	.0004109	29	.0039726	55	.0075342	80	.0109589
4	.0005479	30	.0041095	56	.0076712	81	.0110958
5	.0006849	31	.0042465	57	.0078082	82	.0112328
6	.0008219	32	.0043835	58	.0079452	83	.0113698
7	.0009589	33	.0045205	59	.0080821	84	.0115068
8	.0010958	34	.0046575	60	.0082191	85	.0116438
9	.0012328	35	.0047945	61	.0083561	86	.0117808
10	.0013698	36	:0049315	62	.0084931	87	.0119178
11	.0015068	37	.0050684	63	.0086301	88	.0120547
12	.0016438	38	.0052054	64	.0087671	89	.0121917
13	.0017808	39	.0053424	65	.0089041	90	.0123287
14	.0019178	40	.0054794	66	.0090411	91	.0124657
15	.0020547	41	.0056164	67	.0091780	92	.0126027
16	.0021917	42	.0057534	68	.0093150	93	.0127397
17	.0023287	43	.0058904	69	.0094520	94	.0128767
18	.0024657	44	.0060274	70	.0095890	95	.0130137
19	.0026027	45	.0061643	71	.0097260	96	.0131506
20	.0027397	46	.0063013	72	.0098630	97	.0132876
21	.0028767	47	.0064383	73	.0100000	98	.0134246
22	.0030137	48	.0065753	74	.0101369	99	.0135616
23	.0031506	49	.0067123	75	.0102739	100	.0136986
24	.0032876	50	.0068493	76	.0104109	200	.0273972
25	.0034246	51	.0069863	77	.0105479	300	.0410958
26	.0035616	52	.0071232				

Ex. 1. What is the interest of 250*l.* for 63 days?

.0086301 × 250 = 2*l.* 3*s.* 1¾*d.*

The interest for any number of days not specified in the table, may be easily found by adding two of the numbers contained in it.

Ex. 2. What is the interest of 115*l.* for 237 days?

The interest of 1*l.* for 200 days is .0273972, and for 37 days .0050684, which added together make .0324656; therefore,

.0324656 × 115 = 3*l.* 14*s.* 8*d.* = the interest required.

By the act of 12 Anne, no person is to take for the loan of money, above 5*l.* for the interest of 100*l.* for a year; and all notes, bonds, or other contracts, made for money at a greater rate of interest, are to be void, and the offender to forfeit treble the value.

Interest, *compound*, is, allowing interest upon interest, or, adding the interest as it becomes due to its principal, and considering the whole as a new principal bearing interest at the same rate as before. Let r now represent the amount of one pound in one year, that is, principal and interest; let $n =$ the number of years; $p =$ the principal; $a =$ the amount. Then,

$1 : r :: r : r^2$ the amount of 1*l.* in 2 years

$1 : r :: r^2 : r^3$ the amount of 1*l.* in 3 years

$1 : r :: r^3 : r^4$ the amount of 1*l.* in 4 years, &c.

Whence it appears, that r raised to the power whose exponent is the given number of years, or r^n, will be the amount of 1*l.* in those years; and as

$$1l. : r^n :: p : a$$

from which the following theorems are easily deduced, *viz.* if the principal, time, and rate of interest are given, to find the amount?

Theo. 1. $p \times r^n = a$

If the amount, time, and rate are given, to find the principal?

Theo. 2. $\frac{a}{r^n} = p$

If the principal, amount, and time are given to find the rate?

Theo. 3. $\sqrt[n]{\frac{a}{p}} = r$

If the principal, amount, and rate are given, to find the time?

Theo. 4. $\frac{a}{p} = r^n$, therefore $\frac{a}{p}$ being divided by r till nothing remains, the number of divisions will be n.

It seldom happens, however, that it is necessary to work questions relative to compound interest by these rules, as very extensive and accurate tables have been published by Mr. John Smart and others, which save much labour in such calculations, and are therefore generally resorted to in practice. The principles on which such tables are formed will appear from what has been already said: thus, the numbers in a table shewing the amount of 1*l.* in any given number of years, are merely the powers of 1*l.* increased by its interest for a year; that is, r, r^2, r^3, r^4, &c. and the numbers contained in a table of the present values of 1*l.* to be received at the end of a given number of years, are 1*l.* discounted for those years, or 1*l.* divided by the powers of r, that is, $\frac{1}{r}$, $\frac{1}{r^2}$, $\frac{1}{r^3}$, $\frac{1}{r^4}$, &c.

Tables of this kind being usually confined to six or eight places of decimals, necessarily give the amount beyond the first three or four years somewhat less than the true amount, but the difference is so small as to be of no importance in the purposes to which they are usually applied.

TABLE I.

Shewing the Sum to which 1*l.* Principal will increase at 5 per Cent Compound Interest, in any Number of Years not exceeding a Hundred.

Years.	Amount.	Years.	Amount.	Years.	Amount,	Years.	Amount.
1	1.05	26	3.555672	51	12.040769	76	40.774320
2	1.1025	27	3.733456	52	12.642808	77	42.813036
3	1.157625	28	3.920129	53	13.274948	78	44.953688
4	1.215506	29	4.116135	54	13.938696	79	47.201372
5	1.276281	30	4.321942	55	14.635630	80	49.561441
6	1.340095	31	4.538039	56	15.367412	81	52.039513
7	1.407100	32	4.764941	57	16.135783	82	54.641488
8	1.477455	33	5.003188	58	16.942572	83	57.373563
9	1.551328	34	5.253347	59	17.789700	84	60.242241
10	1.628894	35	5.516015	60	18.679185	85	63.254353
11	1.710339	36	5.791816	61	19.613145	86	66.417071
12	1.795856	37	6.081406	62	20.593802	87	69.737924
13	1.885649	38	6.385477	63	21.623492	88	73.224820
14	1.979931	39	6.704751	64	22.704667	89	76.886061
15	2.078928	40	7.039988	65	23.839900	90	80.730365
16	2.182874	41	7.391988	66	25.031895	91	84.766883
17	2.292018	42	7.761587	67	26.283490	92	89.005227
18	2.406619	43	8.149666	68	27.597664	93	93.455488
19	2.526950	44	8.557150	69	28.977548	94	98.128263
20	2.653297	45	8.985007	70	30.426425	95	103.034676
21	2.785962	46	9.434258	71	31.947746	96	108.186410
22	2.925260	47	9.905971	72	33.545134	97	113.595730
23	3.071523	48	10.401269	73	35.222390	98	119.275517
24	3.225099	49	10.921333	74	36.983510	99	125.239293
25	3.386354	50	11.467399	75	38.832685	100	131.501257

Ex. 1. What sum will 500*l.* increase to in 21 years, if improved at 5 per cent. compound interest?

$500 \times 2.785962 = 1392l.\ 19s.\ 7\frac{1}{4}d.$

Ex. 2. What sum, if improved at 5 per cent. compound interest will accumulate to a million in 50 years?

$$\frac{1000000}{11.467399} = 87203l.\ 14s.\ 8d.$$

The increase of an annuity, if forborne for a given time, may be found by this table in the same manner as the amount of a given sum, for as each payment of the annuity will become due at an equal distance from the time in which it would have been due, the amount of the first payment must give that of each of the succeeding ones.

Ex. 3. A person being entitled to an an-

nuity of 50 guineas per annum, is willing that the same shall not commence till after the expiration of 6 years on being then allowed an equivalent annuity. What must this annuity be?

52.5 × 1.340095 = 70*l.* 7*s.* 1*d.*

TABLE II.

Shewing the present Value of 1l. to be received at the end of any Number of Years not exceeding a Hundred, discounting at the rate of 5 per Cent. Compound Interest.

Years.	Value.	Years.	Value.	Years.	Value.	Years.	Value.
1	.952381	26	.281241	51	.083051	76	.024525
2	.907029	27	.267848	52	.079096	77	.023357
3	.863868	28	.255094	53	.075330	78	.022245
4	.822702	29	.242946	54	.071743	79	.021186
5	.783526	30	.231377	55	.068326	80	.020177
6	.746215	31	.220359	56	.065073	81	.019216
7	.710681	32	.209866	57	.061974	82	.018301
8	.676839	33	.199873	58	.059023	83	.017430
9	.644609	34	.190355	59	.056212	84	.016600
10	.613913	35	.181290	60	.053536	85	.015809
11	.584679	36	.172657	61	.050986	86	.015056
12	.556837	37	.164436	62	.048558	87	.014339
13	.530321	38	.156605	63	.046246	88	.013657
14	.505068	39	.149148	64	.044044	89	.013006
15	.481017	40	.142046	65	.041946	90	.012387
16	.458112	41	.135282	66	.039949	91	.011797
17	.436297	42	.128840	67	.038047	92	.011235
18	.415521	43	.122704	68	.036235	93	.010700
19	.395734	44	.116861	69	.034509	94	.010191
20	.376889	45	.111297	70	.032866	95	.009705
21	.358942	46	.105997	71	.031301	96	.009243
22	.341850	47	.100949	72	.029811	97	.008803
23	.325571	48	.096142	73	.028391	98	.008384
24	.310068	49	.091564	74	.027039	99	.007985
25	.295303	50	.087204	75	.025752	100	.007604

Ex. 1. A person is entitled to receive 1000*l.* at the end of seven years from the present time; what sum paid him immediately would be equivalent thereto?

1000 × .710681 = 710*l.* 13*s.* 7¼*d.*

Ex. 2. What is the present worth of 222*l.* 10*s.* payable 15 years hence?

222.5 × .481017 = 107*l.* 0*s.* 6¼*d.*

Ex. 3. What is the present value of 1392*l.* 19*s.* 7*d.* to be received at the expiration of 21 years?

1392.98 × .358942 = 500*l.*

Tables shewing the present value or amount of annual payments at compound interest are given under the articles ANNUITIES and LEASES.

It is not legal to lend money at compound interest but in granting or purchasing annuities either for lives or for terms of years, it is always usual to compute their value at compound interest; this is particularly the case with respect to sums of money which are not receivable till some future period. See REVERSIONS.

INTEREST, in law, is usually taken for a term, or chattel real, and more particularly for a future term.

INTEREST *of money*, is the premium paid for the use of a sum, and is by law, in this country, limited strictly to five per cent. per annum. See USURY.

Where an estate is devised for payment of debts, chancery will not allow interest for book debts. In case of a vested legacy, due immediately, and charged on land, or money in the funds, which yield an immediate profit, interest shall be payable thereon from testator's death; but if charged only on the personal estate, which cannot be immediately got in, it shall carry interest only from the end of the year after the death of the testator. Where lands are charged with payment of a sum in gross,

they are also chargeable in equity with payment of interest for such sum.

INTERJECTION, in grammar, an indeclinable part of speech, signifying some passion or emotion of the mind. As the greatest part of the expressions used on these occasions are taken from nature alone, the real interjections, in most languages, are monosyllables; and as all nations agree in these natural passions, so do they agree in the signs and indications of them, as of love, mirth, &c. See GRAMMAR.

INTERLOCUTORY *judgments*, in law, are such as are given in the middle of a cause, upon some plea, proceeding, or default, which is only intermediate, and does not finally determine or complete the suit.

INTERLUDE, an entertainment exhibited on the theatre between the acts of a play, to amuse the spectators while the actors take breath and shift their dress, or to give time of changing the scenes and decorations.

INTERMEDIATES, in chemistry, a term made use of when speaking of chemical affinity. Oil, for example, has no affinity to water unless it be previously combined with an alkali, it then becomes soap, and the alkali is said to be the intermedium, which causes the union.

INTERNAL, in general, signifies whatever is within a thing.

Euclid (lib. i. prop. 32) proves, that the sum of the three angles of every triangle is equal to two right angles; whence he deduces several useful corollaries. He likewise deduces, from the same proposition, this theorem, *viz.* that the sum of the angles of every rectilinear figure is equal to twice as many right angles as the figure hath sides, excepting or subtracting four.

INTERPOLATION, among critics, denotes a spurious passage, inserted into the writings of some ancient author. One great rule with regard to the expunging interpolations, is, that the restitution be perfectly agreeable to the rest of the work.

INTERPOLATION, in algebra, is used for finding an intermediate term of a series, its place in the series being given.

INTERROGATION, or *point of* INTERROGATION, in grammar, a character of this form (?) serving to denote a question.

INTERROGATION, in rhetoric, is a figure, whereby the orator proposes something by way of question; which, it must be owned, greatly enlivens the discourse.

INTERSECTION, in the mathematics, signifies the cutting of one line or plane by another. Thus, we say, that the mutual intersection of two planes is a right line. The centre of a circle, or conic section, &c. is in the intersection of two diameters; and the central point of a quadrangle is the intersection of two diagonals.

INTERVAL, in music, the difference between two sounds, in respect of acute and grave; or that imaginary space terminated by two sounds, differing in acuteness or gravity.

When two or more sounds are compared in this relation, they are either equal or unequal in the degree of time: such as are equal are called unisons, with regard to each other, as having one tune; the other, being at a distance from each other, constitute what we call an interval in music; which is properly the distance in time between two sounds. Intervals are distinguished into simple and compound. A simple interval is without parts or divisions. Such are the octave, and all that are within it; as the second, third, fourth, fifth, sixth, and seventh, with their varieties. A compound interval consists of several lesser intervals; such are all those greater than the octave, as the ninth, tenth, eleventh, twelfth, &c. with their varieties.

INTESTINA, in natural history, the first of the five orders of the class Vermes, in the Linnæan system. This order is described as of a formation the most simple, being naked animals without limbs. They live, some of them within other animals, some in waters, and a few in the earth. They are distinguished from the Mollusca, by the want of moveable appendages, or tentacula. There are two divisions.

A, found within other animals, without eyes, of which there are fifteen genera, *viz.*

Ascaris	Ligula
Caryophyllæus	Linguatela
Cucullanus	Scolex
Echynorhynchus	Strongylus
Fasciola	Tænia
Filaria	Tricocephalus
Furia	Uncinariæ.
Hæruca	

B, not inhabiting the bodies of other animals, these are some with and some without a lateral pore, and others perforated with a lateral pore. Of these there are five species, *viz.*

Gordius	Planaria
Hirudo	Sipunculus.
Lumbricus	

We refer the reader to the articles under these words in the alphabetical order; but having omitted Caryophyllæus, we insert it here: Body round; mouth dilated and fringed. One species, *viz.* C. piscium, which inhabits the intestines of various fresh water fish, as the carp, tench, bream, &c.; the body is clay-colour, about an inch long, rounded at the hind part, and broader before.

INTESTINES, in anatomy, long cylindrical, hollow, and membranaceous bodies; or rather, one such continued body, or tube, reaching from the stomach to the anus. See Anatomy.

INTORSION, in botany, a term used to denote the bending of any of the parts of a plant towards one side. This admits of certain distinctions. 1. Twining stems, which bend towards the left, as in hops, honey-suckle, &c.; but in the kidney-bean, convolvolus, &c. they bend to the right. 2. Twining tendrils, which bend to the right and back again; of this kind are the tendrils of most of the pea-bloom or leguminous tribe of plants. 3. Twisted flowers, in the periwinkle, the petals bend to the left; the pointal in the viscous campion is twisted to the left, as the seed-bud is in the screw-tree. In oats, the beard which terminates the husk is twisted like a rope. This species of contorsion being affected by the moisture or dryness of the atmosphere, is denominated by Linnæus, "intorsio hygrometrica." Another species of intorsion is the appearance of the petals in the violet, basil, &c. in which the upper lip of the corolla looks to the ground, and the under lip upwards.

INTRADOS, in architecture, the interior and lower side, or curve, of the arch of a bridge; in contradistinction from the extrados, or exterior curve, or line, on the upper side of the arch.

INTRINSIC, a term applied to the inner, real, and genuine values, properties, &c. of any thing, in opposition to their extrinsic or apparent values, &c.

INTUITION, among logicians, the act whereby the mind perceives the agreement or disagreement of two ideas, immediately by themselves, without the intervention of any other; in which case, the mind perceives the truth as the eye doth the light, only by being directed towards it. Thus the mind perceives that white is not black, that three are more than two, and equal to one and two. This part of knowledge, says Mr. Locke, is irresistible, and, like the sunshine, forces itself immediately to be perceived as soon as ever the mind turns its view that way. It is on this intuition that all the certainty and evidence of our other knowledge depends; this certainty every one finds to be so great, that he cannot imagine, and therefore cannot require, a greater.

INVECTED, in heraldry, denotes a thing fluted or furrowed. Invected is just the reverse of ingrailed, in which the points are turned outward to the field, whereas in invected they are turned inward to the ordinary, and the small semicircles outward to the field.

INVECTIVE, in rhetoric, differs from reproof, as the latter proceeds from a friend, and is intended for the good of the person reproved; whereas the invective is the work of an enemy, and entirely designed to vex and give uneasiness to the person against whom it is directed.

INVENTION, denotes the act of finding any thing new, or even the thing thus found. Invention is, according to Lord Bacon, of two very different kinds, the one of arts and sciences, the other of arguments and discourse: the former he sets down as absolutely deficient. That the other part of knowledge is wanting, says he, seems clear; for logic professes not, nor pretends to invent either mechanical or liberal arts; nor to deduce the operations of the one, or the axioms of the other, but only leaves us this instruction, "To believe every artist in his own art." His lordship further maintains, that men are hitherto more obliged to brutes than reason for inventions. Whence those who have written concerning the first inventors of things, and origin of sciences, rather celebrate chance than art, and bring in beasts, birds, fishes, and serpents, rather than men, as the first teachers of arts. No wonder, thefore, as the manner of antiquity was to consecrate the inventors of useful things, that the Egyptians, to whom many arts owe their rise, had their temples filled with the images of brutes, and but a few human idols amongst them.

Invention is, therefore, used for a subtlety of mind, or somewhat peculiar in a man's genius, which leads him to the discovery of things new; whence we say a man of invention. Invention, according to Du Bos, is that part which constitutes the principal merit of works, and distinguishes the great genius from the simple artist.

Invention, in rhetoric, being one of the second divisions of invention, according to Bacon, signifies the finding out and choos-

ing of arguments which the orator is to use for proving his point, or moving his hearers passions.

This invention, in the opinion of that philosopher, cannot properly be called invention, which is the discovery of things not yet known, and not the recollecting things that are known; the only use and office of this rhetorical invention being out of the stock of knowledge already laid up, to select such articles as make for the purpose. The same author divides the method of procuring a stock of matter for discourse into two; the first of which is either by marking out and indicating the parts wherein a thing is to be searched after, which he calls the topical way; and the second is by laying up arguments for use that were composed before hand, and which he calls the promptuary way.

INVENTION, in poetry, is applied to whatever the poet adds to the history of the subject he has chosen, as well as to the new turn he gives it.

INVENTION, in painting, is the choice which the painter makes of the objects that are to enter the composition of his piece.

IN VENTRE SA MERE, is where a woman is with child at the time of her husband's death; which child, if he had been born, would be heir to the land of the husband. A devise to an infant in ventre sa mere, is good, by way of future executory devise. And where a daughter comes into land by descent, the son, born after, shall put her out, and have the land.

INVERSE, is applied to a manner of working the rule of three, or proportion, which seems to go backward, or contrary to the order of the common or direct rule. See PROPORTION.

INVERSE *proportion*, or INVERSE *ratio*, in philosophy, is that in which more requires less, or less requires more. Thus, in the case of light and heat flowing from a luminous body, the light and heat are less at a greater distance; and greater at a less distance; so that in this instance more gives less, or a greater distance receives less light and heat; and less gives more, that is a person coming nearer the illuminated body receives more light and heat than he would at a greater distance. This is expressed in different books, in different ways, sometimes by the term inversely, sometimes by the term reciprocally, as in the case referred to, we say the light and heat are inversely, or reciprocally, as the square of the distance; or in the inverse, or reciprocal, duplicate ratio of the distance.

INVERSION, or as it is in Euclid, *invertendo*, or by inversion, is inverting the terms of a proportion by changing the antecedents into consequents, and the consequents into antecedents: thus, if

$$a : b :: c : d$$
$$4 : 9 :: 12 : 27$$

Then by inversion it will be

$$b : a :: d : c$$
$$9 : 4 :: 27 : 12$$

INVERSION, in music, is a changed position either of a subject or of a chord. The inversion of a subject is produced by giving it a higher or lower situation among the several parts of a score, sometimes making it the bass, at other times the tenor, counter-tenor, or the treble. The inversion of a chord is that changed position of its component parts, with respect to its fundamental bass, by which, though the harmony remain the same, the intervals are varied, and the compound assumes another name.

INVERSION, in grammar, is where the words of a phrase are ranged in a manner not so natural as they might be. It is a considerable beauty either in verse or prose, when we have it from an able hand; it gives vigour and variety to a sentence, and keeps the mind in an agreeable suspense and expectation of a marvellous turn and conclusion.

INVESTIGATION, properly denotes the searching or finding any thing out by the tracts or prints of the feet; whence mathematicians, schoolmen, and grammarians, come to use the term in their respective researches.

INVESTITURE, in law, is the giving possession of lands by actual seisin. The ancient feudal investiture was, where the vassal or descent of lands was admitted in the lord's court, and there received his seisin, in the nature of a renewal of his ancestor's grant, in the presence of the rest of the tenants; but in after-times, entering on any part of the lands, or other notorious possession, was admitted to be equivalent to the formal grant of seisin and investiture.

INULA, in botany, *common inula*, or *elecampane*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: receptacle naked; down simple; anthers ending in two bristles at the base. There are thirty-four species; these are generally

herbaceous plants; leaves simple, alternate; flowers yellow, axillary or terminating, frequently in corymbs. I. helenium, common inula, or elecampane, has a perennial, fusiform, branching, aromatic root; according to some botanists it is biennial. It is from three to five feet high, and one of the largest of our herbaceous plants; lower leaves on foot stalks, lanceolate, a foot long, and four inches broad in the middle; flowering heads very large, single, terminating the stem and branches; florets all yellow, those of the ray narrow, linear, from an inch to an inch and half in length, with three sharp teeth at the end; pappus, egret or down-white, twice as long as the seed, appearing to be capillary; but when viewed with a glass, finely toothed on one side, shorter than the florets, sessile. Native of Japan, Denmark, Germany, Flanders, &c. The officinal name is enula campana, whence our English name elecampane is derived.

INUNDATÆ, in botany, the name of the fifteenth order in Linnæus's "Fragments of a Natural Method," consisting of plants which grow in the water. Among these may be mentioned the ceratophyllum, horned pond-weed, and elatine, water-wort. The plants of this order are as the name imports, aquatic, low, herbaceous, and mostly perennial; the roots are fibrous; the stem is usually wanting, and in its stead is an assemblage of leaves which, unfolding one another mutually, form a sheath, from the middle of which is produced the foot-stalk of the flower; the leaves are sometimes alternate, sometimes placed in whorls round the stem; the flowers are hermaphrodite in some, as the pond-weed; and on others, the male and female are in the same root; the flowers, in some cases, proceed singly from the wings of the leaves, as in the ceratophyllum, elatine, and hippuris; those of the lower leaves of the myriophyllum, water-milfoil, are female; those of the upper male. The zannichellia, triple-headed pond-weed, has two flowers in the same wing; one male and the other female. The flowers in potamogeton, pond-weed, and ruppia, are disposed in specks in the wings of the leaves; the flower-cup is either wanting, or consists of three, four, or five divisions or leaves; the petals are generally wanting, but the elatine and pond-weed have four; the stamina are in number from one to sixteen and upwards; the seed-buds are from one to four; the style is frequently wanting, as the seed-vessel is universally, except in the elatine, which has a dry capsule, with four external openings, and the same number of cells; there are generally four seeds; but in the ceratophyllum the fruit is a nut or stone, egg-shaped, and containing a single cell.

INVOICE, an account, in writing, of the particulars of merchandise, with their value, custom, charges, &c. transmitted by one merchant to another in a distant country. One copy of every invoice is to be inserted verbatim in the invoice-book, for the merchant's private use; and another copy must, immediately upon shipping off the goods, be dispatched by post, or otherwise, to the correspondent. This copy is commonly drawn out upon a sheet of large post paper, to the end of which is subjoined a letter of advice.

It must here be observed, that when a merchant ships off goods for his own account, the invoice sent to the factor contains only the quantity of goods, but nothing of the cost and charges; and the letter subjoined consists of instructions, signifying in what manner the employer inclines to have his goods disposed of, and returns made.

INVOICE *book*, this book is paged, and contains copies of the invoices of goods sent to sea; for as a merchant is obliged to send his correspondent an invoice of all the goods he consigns to him, so it is reasonable that he should keep a copy of it for himself. For the further uses of invoice-books, see BOOK *of invoices*.

INVOLUCRUM. See BOTANY.

INVOLUTE, *figure*, or *curve*, in the higher geometry, is that which is traced out by the outer extremity of a string, as it is folded or wrapped upon another figure, or as it is unwound from off it. The involute of a cycloid is also a cycloid equal to the former, a part that was discovered by Huygens, and by means of this he fell upon the plan of making a pendulum vibrate in the curve of a cycloid, and in equal times, whatever be the length of the curve.

INVOLUTION, in algebra, the raising a quantity from its root to any power assigned. See ALGEBRA.

JOINERY, the art of working in wood, or of fitting various pieces of timber together. It differs from the art of the carpenter, inasmuch as the joiner is employed chiefly in the inside work of a house, but the carpenter does the rough work, which, in general, requires more strength and less skill.

JOINT, in general, denotes the juncture

of two or more things. The joints of the human body are called by anatomists articulations. The term joint is also applied to the separation between the stones or bricks of a building, usually filled with mortar, plaster, or cement; also by carpenters, to the several manners of assembling or fitting pieces of wood together; as a dove-tail joint, &c.

JOINT, *universal*, an invention adapted to all kinds of motions and flexures. This was probably the origin of the gimbols used in suspending the mariner's compass. By means of the universal joint, the pull of a bell may be carried to any part of a room, and made to act as well in one place as in another.

JOINT STOCK COMPANIES. About the time of the famous Mississipi sheme in France, and the South Sea scheme in England, there arose a sort of epidemic fever of speculation, and every one was anxious to join in some partnership, for carrying on speculations in foreign commerce or domestic trade, by companies of persons uniting several individual stocks of small amount into one common fund. At the best, it has been observed, that trade, so carried on by large companies, is not very beneficial to the individuals who engage in it, or if it were so, would be greatly prejudicial to the public in general, and to other individuals trading on their own capitals. At the period above mentioned, about 1718 and 1724, many serious consequences ensued from this spirit of speculation, many frauds were committed by adventurers taking advantage of it, and the whole nation was in a manner convulsed by the injuries which the people at large suffered from it, many families having been reduced to utter ruin by it. To prevent these evils occurring in future, the following enactments were passed: stat. 16 George I. c. 18, s. 18, 19, 20, 21; by which, after reciting, that whereas it is notorious, that several undertakings or projects of different kinds have, at some time or times since the four-and-twentieth day of June, one thousand seven hundred and eighteen, been publicly contrived and practised, or attempted to be practised, within the city of London, and other parts of this kingdom, as also in Ireland, and other his Majesty's dominions, which manifestly tend to the common grievance, prejudice, and inconvenience of great numbers of your Majesty's subjects, in their trade or commerce, and other their affairs; and the persons who contrive or attempt such dangerous and mischievous undertakings or projects, under false pretences of public good, do presume, according to their own devices and schemes, to open books for public subscriptions, and draw in many unwary persons to subscribe therein, towards raising great sums of money, whereupon the subscribers, or claimants under them, do pay small proportions thereof, and such proportions, in the whole, do amount to very large sums; which dangerous and mischievous undertakings, or projects, do relate to several fisheries, and other affairs, wherein the trade, commerce, and welfare of your Majesty's subjects, or great numbers of them, are concerned or interested: and whereas, in many cases the said undertakers or subscribers have, since the said four-and-twentieth day of June, one thousand seven hundred and eighteen, presumed to act as if they were corporate bodies, and have pretended to make their shares in stocks transferrable or assignable, without any legal authority, either by act of Parliament, or by any charter from the crown, for so doing, &c.: it is enacted, by authority of this present Parliament, that from and after the four-and-twentieth day of June, one thousand seven hundred and twenty, all and every the undertakings and attempts described as aforesaid, and all other public undertakings and attempts, tending to the common grievance, prejudice, and inconvenience of his Majesty's subjects, or great numbers of them, in their trade, commerce, or other lawful affairs, and all public subscriptions, receipts, payments, assignments, transfers, pretended assignments and transfers, and all other matters and things whatsoever, for furthering, countenancing, or proceeding in any such undertaking or attempt, and more particularly, the acting, or presuming to act, as a corporate body or bodies; the raising, or pretending to raise, transferrable stock or stocks; the transferring, or pretending to transfer or assign any share or shares in such stock or stocks, without legal authority, either by act of Parliament, or by any charter from the crown, to warrant such acting as a body corporate, or to raise such transferable stock or stocks, or to transfer shares therein, and all acting, or pretending to act, under any charter, formerly granted from the crown, for particular or special purposes therein expressed, by persons who do or shall use, or endeavour to use, the same charters, for raising a capital stock, or for making transfers or assignments, or pre-

tended transfers or assignments of such stock, not intended or designed by such charter to be raised or transferred, and all acting, or pretending to act, under any obsolete charter become or voidable by nonuser or abuser, or for want of making lawful elections, which were necessary to continue the corporation thereby intended, shall (as to all or any such acts, matters, and things as shall be acted, done, attempted, or endeavoured, or proceeded upon, after the said four-and-twentieth day of June one thousand seven hundred and twenty) for ever, be deemed to be illegal and void, and shall not be practised, or, in anywise, put in execution. And further, the parties offending, by committing any of the acts above enumerated, and more particularly, the presuming or pretending to act as a corporate body, or to raise a transferrable stock or stocks, or to make transfers or assignments of any share or shares therein, without such legal authority as aforesaid, &c. shall be deemed to be a public nuisance and nuisances: and all offenders therein, being thereof lawfully convicted, shall be liable to such fines and penalties as persons convicted for public nuisances are; and moreover shall incur any further pains, penalties, and forfeitures, provided by the statute of provisions and præmunire, made in the sixteenth year of the reign of King Richard the second.

If any merchant or trader, at any time after the said four-and-twentieth day of June, one thousand seven hundred and twenty, shall suffer any particular damage in his, her, or their trade, commerce, or other lawful affairs, by occasion or means of any undertaking or attempt, matter, or thing, by this act declared to be unlawful, as aforesaid, and will sue to be relieved therein, then, and in every such case, such merchant or trader shall and may have his and their remedy for the same, by an action or actions to be grounded upon this statute, against the persons, societies, or partnerships, or any of them, who, contrary to this act, shall be engaged or interested in any such unlawful undertaking or attempt; and in every such action, the plaintiff shall or may recover treble damages, with full costs of suit.

By s. 21, if any broker, or person acting as a broker, shall bargain, sell, buy, or purchase, or contract, or agree for the bargaining, &c. of any share or interest in any of the undertakings by the act declared illegal, he shall be rendered incapable of acting as a broker, and forfeit 500*l*., one moiety to the King, and the other to the informer.

S. 25, this act is not to prohibit the carrying on of any home or foreign trade in partnership, in such manner as has been usually, and may be legally done, except in insurances, &c.

These enactments have, for many years since the passing of them, in 1721, not been enforced, except in the instance of one Cafwood, Michaelmas, 8 George I., Strange Rep. 472, and Lord Raymond, 1361, who was fined 5*l*. and imprisoned during his Majesty's pleasure, for being the projector of an unlawful undertaking to trade to the North Sea. In the interval between that time and the present, (1808) many institutions have been formed and carried on in direct violation of the act, such as fire and life insurance companies, which are all beneficial to the community, as they necessarily would be, if carried on with regularity and good faith. The success of these institutions has given rise to many speculations in more recent times, which were not of such obvious utility; and a Mr. Dodd, having projected a distillery, by a joint-stock company, became an object of jealousy to some private distillers, who applied to the court of King's Bench for leave to file a criminal information against him; upon which the court pronounced him within the words of the act, which prohibit the raising of joint-stock shares; but refused to interfere, on account of the length of the time during which the statute had lain dormant.

The words of this statute are so clear, that, to the writer of this article, it appears strange that they could ever be misunderstood. They prohibit all combinations in trade, except partnerships and lawful corporations established by act of Parliament, or royal charter; and when the nature of mercantile contracts is considered, the law could not safely do otherwise; for it would leave the unwary open to the grossest frauds, and the most ruinous self-delusion. A corporation is not the mere fanciful essence which it is ignorantly deemed to be: it is a combination formed upon a strict view of legal principles, and the commerce of mankind; upon the only plan on which large bodies of men can be enabled to contract with individuals. In trusting to a corporation, there must be a permanent fund, out of which to answer all obligations, because no individual is answerable personally. Corporations must be confined only,

therefore, to those cases in which dealings are simple, and in which a permanent fund can be kept together. Partnerships depend altogether upon individual responsibility, and can therefore not safely be composed of many persons; for in suing and being sued, all the partners must be named. This inconvenience has been attempted to be remedied by making acts of Parliament, to enable certain fire companies, the Albion, Globe, &c. to sue and be sued by their chief clerk, without making them corporations: yet, as they stipulate not to be answerable beyond their individual shares, it will be found difficult, if not impossible, to levy execution upon them, and the party must still sue out one or two thousand writs of fieri facius, for a debt of 20*l*. Such is the consequence of interfering with the established common law. The result will be found to be, that in all such cases, the public deal with a body of people upon honour and good faith only, and each individual embarks all his fortune in such concerns, and being once engaged in them, continues still liable. Whether it would be feasible to give further facility to the erecting of trading corporations, considering the advantages of some such institutions, is therefore a question of great difficulty both in political œconomy and legislation.

JOINT *tenants*, are those that come to, and hold lands or tenements by one title, *pro indiviso*, or without partition. These are distinguished from sole or several tenants, from parceners, and from tenants in common; and they must jointly implead, and jointly be impleaded by others, which property is common between them and coparceners; but joint tenants have a sole quality of survivorship, which co-parceners have not; for if there be two or three joint tenants, and one hath issue and dies, then he or those joint tenants that survive, shall have the whole by survivorship. The creation of an estate in joint tenancy depends on the wording of the deed or devise, by which tenant claims title, and cannot arise by act of law. If any estate be given to a plurality of persons, without adding any restrictive, exclusive or explanatory words, as if an estate be granted to A and B, and their heirs, this makes them immediately joint tenants in fee of the lands. If there be two joint tenants, and one release the other, this passes a fee without the word heirs, because it refers to the whole fee, which they jointly took, and are possessed of by force of the first conveyance; but the tenants in common cannot release each other, for a release supposes the party to have the thing in demand; but tenants in common have several distinct freeholds, which they cannot tranfer otherwise than as persons who are sole seized. Although joint tenants are seized *per mie et per tout*, yet to divers purposes, each of them hath but a right to a moiety; as, to enfeoff, give or demise, or to forfeit or lose by default in a præcipe; and therefore where there are two or more joint tenants, and they all join in a feoffment, each of them in judgment gives but his part.

At common law, joint tenants in common were not compellable to make partition; except by the custom of some cities and boroughs. But now joint tenants may make partition; the one party may compel the other to make partition, which must be by deed: that is to say, all the parties must by deed actually convey and assure to each other the several estates, which they are to take and enjoy severally and separately. Joint tenants being seized *per mie et per tout*, and deriving by one and the same title, must jointly implead, and be jointly impleaded with others. If one joint tenant refuse to join in an action, he may be summoned and severed; but if the person severed die, the writ abates in real actions, but not in personal and mixed actions.

JOINTURE, a jointure, strickly speaking, signifies a joint estate, limited to both husband and wife; but in common acceptation, it extends also to a sole estate, limited to the wife only, and may be thus defined, *viz.* a competent livelihood for the wife of freehold of lands and tenements, to take effect, in profit or possession, presently after the death of the husband; for the life of the wife at least. By the statute of 27 Henry VIII. c. 10. if a jointure be made to the wife, it is a bar of her dower, so as she shall not have both jointure and dower. And to the making of a perfect jointure within that statute six things are necessary to be observed. 1. Her jointure is to take effect presently after her husband's decease. 2. It must be for the term of her own life, or greater estate. 3. It should be made to herself. 4. It must be made in satisfaction of her whole dower, and not of part of her dower. 5. It must either be expressed or averred to be in satisfaction of her dower. 6. It should be made during the coverture.

The estate should be made to herself; but as the intention of the statute was to

secure the wife a competent provision, and also to exclude her from claiming dower, and likewise her settlement, it seems that a provision or settlement on the wife, though by way of trust, if in other respects it answer the intention of the statute, will be enforced in a court of equity. It should be made during the coverture; this the very words of the act of parliament require, and therefore if a jointure be made to a woman during her coverture in satisfaction of dower, she may wave it after her husband's death; but if she enter, and agree thereto, she is concluded; for though a woman is not bound by any act when she is not at her own disposal, yet if she agree to it when she is at liberty, it is her own act, and she cannot avoid it.

JOISTS, in architecture, those pieces of timber framed into the girders and summers, on which the boards of the floor are laid. See ARCHITECTURE and BUILDING.

IONIC *order*, the third of the five orders of architecture, being a kind of mean between the robust and delicate orders. See ARCHITECTURE.

IONIC *dialect*, in grammar, a manner of speaking peculiar to the people of Ionia. At first it was the same with the antient Attic; but passing into Asia, it did not arrive at that delicacy and perfection to which the Athenians attained. The Ionians generally changed the ω into η, as σοφια into σοφιη; they put the η and ι for ε, and αιη for η, as αγγηϊον for αγγειον: αναγκαιη for αναγκη: they also change α and ει into ηϊ, αυ into ωϋ, ει into εα and εε, ευ into ω and ηϋ, and εο into ευ.

JONCQUETIA, in botany, so named in memory of Denis Joncquet, a genus of the Decandria Tetragynia class and order. Essential character: calyx five-leaved; petals five, spreading; filaments growing to a glandule; styles none; capsule sub-globular, one-celled, five-valved, five-seeded. There is but one species, *viz.* J. guianensis, a large tree, forty to fifty feet high, and about three in diameter with a russet bark, and a white uncompact wood; it has a great number of branching boughs at the top, those in the middle erect, the rest horizontal, spreading in all directions. Native of Guiana.

JONES (INIGO), an eminent architect, was the son of a clothworker in London, and was born in that city about 1572. Scarcely any thing is known of the manner in which he passed his early years, but it is probable that he enjoyed few advantages of education, and was destined to a mechanical employment. He displayed, however, a talent for the fine arts, which attracted the notice of some lords about the court, among whom were the Earls of Arundel and Pembroke. The latter of these noblemen has generally the credit of becoming his patron, and sending him into Italy for the purpose of perfecting himself in landscape painting, to which his genius seemed first to point. He took up his residence chiefly at Venice, where the works of Palladio gave him a turn to the study of architecture, which branch of art he made his profession. He acquired a reputation in that city, which procured him an invitation from Christian IV. King of Denmark, to come and occupy the post of his first architect. He was some years in the service of that sovereign, whom he accompanied, in 1606, on a visit to his brother-in-law, King James, and, expressing a desire of remaining in his native country, he was appointed architect to the Queen. He served Prince Henry in the same capacity, and obtained a grant in reversion of the place of Surveyor General of the Works. After the death of the Prince, Jones again visited Italy, where he pursued further improvement during some years. When the Surveyor's place fell, he returned to occupy the office, and finding the Board of Works much in debt, he relinquished his own dues, and prevailed upon the Comptroller and Paymaster to do the same, till all arrears were cleared.

The King, in 1620, set him a task better suited to a man of learning than an artist, which was, to exercise his ingenuity in conjecturing the founders and the purpose of that remarkable remain of antiquity, Stonehenge. Jones, whose ideas were all Roman, convinced himself that it ought to be ascribed to that people, and wrote a treatise to prove his point; but of all the guesses relative to that structure, this has least obtained the concurrence of sound antiquarians. At that time he was building the banquetting-house at Whitehall, which was meant only as a pavilion to a splendid palace intended to be erected, and of which there exists a magnificent design from his ideas. The banquetting-house subsists, a model of the pure and elegant taste of the architect. He was in that reign appointed a commissioner for repairing the cathedral of St. Paul's, which office, as well as his other posts, were continued to him under Charles I. The entertain-

ments, called masques, introduced by James's queen, Anne of Denmark, and in vogue during the gay part of the succeeding reign, gave Jones frequent employment in the invention of the scenery and decorations. The poetical composer of most of these pieces was Ben Jonson, between whom and Jones a violent quarrel took place, productive of much virulent abuse, in detestable verse, on the part of the testy bard. It appears that the architect too, was a dabbler in poetry, which, perhaps, might be the occasion of the difference between them.

The repairs of St. Paul's did not commence till 1633. Of our architect's performance in this business, Mr. Walpole thus speaks: "In the restoration of that cathedral, he made two capital faults. He first renewed the sides with very bad Gothic, and then added a Roman portico, magnificent and beautiful indeed, but which had no affinity with the ancient parts that remained, and made his own Gothic appear ten times heavier. He committed the same error at Winchester, thrusting a screen in the Roman or Grecian taste, into the middle of that cathedral. Jones, indeed, was by no means successful when he attempted Gothic." He had much employment both from the court and among the nobility, and realized a handsome fortune, which was diminished by sufferings during the troubles which succeeded. He was obnoxious, both as a favourite of his royal master, and as a Roman Catholic. The first attack made upon him was in 1640, when he was called before the House of Lords, on a complaint of the parishioners of St. Gregory's, for demolishing part of their church, in order to make room for his additions to St. Paul's. In 1646 he was obliged to pay 545*l*. by way of composition as a malignant.

The King's death greatly affected him; and he died, worn down by grief and misfortune, in July, 1651. He is said to have been a skilful geometrician, and to have been well acquainted with various branches of knowledge. He was certainly the greatest English architect previous to Sir Christopher Wren. His designs with the pen were highly valued by Vandyke. A collection of them was engraved and published by Mr. Kent, in two volumes folio, 1727, and some lesser designs in 1744. Others were published in 1743, 4to., by Mr. Ware. A copy of Palladio's Architecture, with manuscript notes by Jones, is in the library of Worcester College, Oxford. Mr. Walpole has given a catalogue of the principal buildings erected and decorated by this architect.

Jones (William), in biography, a very eminent mathematician in the seventeenth and former part of the eighteenth century, was born in the parish of Llanfihangel trer Bard, at the foot of Bodavon mountain in the Isle of Anglesea, North Wales, in the year 1680. His parents were yeomen, or small farmers, on that island, and he there received the best education which they were able to afford; reading, writing, and accounts, in English, and the Latin grammar. Having, however, an extraordinary turn for mathematical studies, by the industrious exertion of vigorous intellectual powers, he supplied the defects of adequate instruction, and laid the foundation of his future fame and fortune. He began his career in life by teaching mathematics on board a man of war; and in this situation he attracted the notice, and obtained the friendship, of Lord Anson. In his twenty-second year, Mr. Jones published "A New Compendium of the whole Art of Navigation," &c. 8vo., which is a neat little piece, and was received with great approbation. He was present at the capture of Vigo, in the same year, and having joined his comrades in quest of pillage, he eagerly fixed upon a bookseller's shop as the object of his depredation; but finding in it no literary treasures, which were the sole plunder that he coveted, he contented himself with a pair of scissars, which he frequently exhibited to his friends as a trophy of his military success, relating the anecdote by which he gained it. After the return of the fleet to England, he immediately established himself as a teacher of mathematics in London, where, in the year 1706, he published his "Synopsis Palmariorum Matheseos;" or, "A New Introduction to the Mathematics," &c. containing a perspicuous and useful compendium of all the mathematical sciences, and affording a decisive proof of his early and consummate proficiency in his favourite studies. The private character of Mr. Jones was respectable, his manners were agreeable and inviting; and those qualities not only contributed to enlarge the circle of his friends, whom his established reputation for science had attracted, but also to secure their attachment to him.

Among others who honoured him with their esteem, was the great and virtuous Lord Hardwicke, whom he attended as a

companion on the circuit, when he was Chief Justice; and this nobleman, when he afterwards held the Great Seal, availed himself of the opportunity to testify his regard for the merit and character of his friend, by conferring upon him the office of secretary for the peace. He was also introduced to the friendship of Lord Parker, (afterwards President of the Royal Society) which terminated only with his death; and amongst other distinguished characters in the annals of science and literature, the names of Sir Isaac Newton, Halley, Mead, and Samuel Johnson, may be enumerated as the intimate friends of Mr. Jones. By Sir Isaac Newton he was treated with particular regard and confidence; and having afterwards found among some papers of Collins which fell into his hands, a tract of Newton's, entitled, "Analysis per quantitatum Series, Fluxiones, ac differentias: cum Enumeratione Linearum tertii Ordines;" with the consent and assistance of that great man, he ushered it into the world, accompanied by other pieces on analytical subjects in 1711, quarto.

By being thus the means of preserving some of Newton's papers, which might have otherwise been lost, he secured to his friend the honour of having applied the method of infinite series to all sorts of curves, some time before Mercator had published his "Quadrature of the Hyperbola," by a similar method. And its appearance at a time when the dispute ran high between Leibnitz and the friends of Newton, concerning the invention of fluxions, contributing to the decision of the question in favour of our illustrious countryman.

Mr. Jones was elected a member, and afterwards a Vice-President of the Royal Society. After the retirement of Lord Macclesfield to Sherborne Castle, Mr. Jones resided with his Lordship as a member of his family, and instructed him in the sciences. While he was in this situation, he had the misfortune to lose the greatest part of his property, the accumulation of industry and economy, by the failure of a banker; but the friendship of Lord Macclesfield diminished the weight of the loss, by procuring for him a sinecure place of considerable emolument. From the same nobleman he had the offer of a more lucrative situation; but he declined the acceptance of it, as it required a more close official attendance than was agreeable to his temper, or compatible with his attachment to scientific pursuits.

While he was in this situation also, he entered into a matrimonial connection, from which sprang three children, the last of whom was the late Sir William Jones. Mr. Jones survived the birth of this son only three years, being attacked with a disorder, which the sagacity of Dr. Mead, who attended him with the anxiety of an affectionate friend, immediately discovered to be a polypus of the heart, and wholly incurable. He died in July 1749, when about sixty-nine years of age, leaving behind him a great reputation and moderate property.

"The history of men of letters," says Lord Teignmouth, from whom we have chiefly extracted the preceding particulars, "is too often a melancholy detail of human misery, exhibiting the unavailing struggles of genius and learning against penury, and life consumed in fruitless expectation of patronage and reward. We contemplate with satisfaction the reverse of this picture in the history of Mr. Jones, as we trace him in his progress from obscurity to distinction, and in his participation of the friendship and beneficence of the first characters of the times. Nor is it less grateful to remark, that the attachment of his professed friends did not expire with his life; after a proper interval they visited his widow, and vied in their offers of service to her; amongst others, to whom she was particularly obliged, I mention with respect Mr. Baker, author of a treatise on the improved microscope, who afforded her important assistance, in arranging the collection of shells, fossils, and other curiosities, left by her deceased husband, and in disposing of them to the best advantage."

Mr. Jones's papers in the Philos. Trans. are, "A Compendious Disposition of Equations for exhibiting the Relations of Goniometrical Lines," in the forty-fourth volume; "A Tract on Logarithms," in the sixty-first; "An Account of the Person killed by Lightning in Tottenham-court Chapel, and its Effects on the Building," in the sixty-second; and "Properties of the Conic Sections, deduced by a Compendious Method," in the sixty-third volume. These pieces, and indeed all his works, are distinguished by remarkable neatness, brevity, accuracy, and perspicuity. If, however, Mr. Nichols is not deceived in his information, the world has been deprived of his last and most laborious work, which he lived to complete, but not to see it printed. It was a work of the same nature with his

"Synopsis," but far more copious and diffusive, and intended to serve as a general introduction to the sciences, or, which is the same thing, to the mathematical and philosophical works of Newton. A work of this kind was a desideratum in literature, and it required a geometician of the first class to sustain the weight of so important an undertaking; for which, as D'Alembert justly observes, "the combined force of the greatest mathematicians would not have been more than sufficient."

Mr. Jones was fully aware of the arduous nature of such a task; but the importunity of his numerous acquaintance, and particularly of his friend Lord Macclesfield, induced him to commence, and to persist till he had completed, his design, the result of all his knowledge and experience, and what he had reason to hope would prove a lasting monument of his talents and industry. Scarcely had he sent the first sheet to the press, when his illness, which proved fatal, obliged him to stop the impression; but before his death he entrusted his MS. fairly transcribed, to the care of Lord Macclesfield, who promised to publish it, as well for the honour of the author as the benefit of his family. The Earl survived his friend many years; but the MS. was forgotten or neglected, and after Lord Macclesfield's death was not to be found. Whether it was accidentally destroyed, or whether, as has been suggested, it was lent to some geometrician, who basely concealed it, or possibly burnt the original, to prevent the advantages which he derived from it from detection, cannot now be ascertained. Such is the relation given in the "Anecdotes of Bowyer," on which Lord Teignmouth remarks, that their is no evidence in the memoranda left by Sir William Jones to confirm or disprove these assertions. Mr. Jones is said to have possessed the best mathematical library in England, containing almost every book of that kind which was to be met with. By a bequest in his will, it became the property of Lord Macclesfield, and forms at present a distinguished part of the Macclesfield collection at Sherborne Castle, in Oxfordshire. He had also collected a great quantity of MS. papers and letters of former mathematicians, which have often proved useful to the writers of their lives, &c. After his death these were dispersed, and fell into the hands of different persons, and, among others, into those of Mr. Robertson, librarian and clerk to the Royal Society, from whose executors Dr. Hutton purchased a considerable number of them.

JONK, or Jonque, in naval affairs, is a kind of small ship, very common in the East Indies: these vessels are about the bigness of our fly-boats, and differ in the form of their building, according to the different methods of naval architecture used by the nations to which they belong. Their sails are frequently made of mats, and their anchors are made of wood.

JOURNAL, a day-book, register, or account of what passes daily.

Journal, or Day-book, among merchants, is that wherein the transactions recorded in the waste-book are prepared to be carried to the ledger, by having their proper debtors and creditors ascertained and pointed out. For a more distinct account of which see Book-keeping.

Journal, at sea, is a register, kept by the pilot and others, wherein notice is taken of every thing that happens to the ship from day to day, with regard to the winds, the rhumbs, the rake, soundings, &c. and in order to enable him to adjust the reckoning, and determine the place where the ship is.

In sea journals, the day, or twenty-four hours, terminate at noon, because the errors of the dead reckoning are at that period generally corrected by a solar observation. The first twelve hours, from noon to midnight, are marked with P. M. signifying after mid-day; and the second twelve hours from mid-night to noon, are marked with A. M. signifying after midnight; so that the ship account is twelve hours earlier than the shore account of time. There are various ways of keeping journals, according to the different notions of mariners concerning the articles that are to be entered. Some keep such a kind of journal as is only an abstract of each day's transactions, specifying the weather, what ships or lands were seen, accidents on board, the latitude, longitude, the meridional distance, course, and run. These particulars are to be drawn from the ship's log-book, or from that kept by the pilot himself. Others keep only one account, including the log-book, and all the work of each day, with the deductions drawn from it. Notwithstanding the form of keeping journals is very different in merchant ships, yet one method appears to be invariably pursued in the navy, which, however, admits of much improvement, for no form can be properly called perfect that leaves as great

a space for one day's work, which may not be interesting, and can therefore be told in a few lines, as for another, which may probably abound with important incidents, and consequently require much room. According to circumstances the matter must be greater or less, and the appropriated space should admit of all.

JOURNEYMAN, properly one who works by the day only; but it is now used for any one who works under a master, either by the day, the year, or the piece.

JOY, one of the most powerful mental emotions accompanied with an extraordinary degree of animation and pleasure. The effect of joy, if not too violent, invigorates the whole animal frame. But sudden and excessive joy is often as injurious as the operation of either grief or terror, and there are a thousand instances on record, in which the precipitate communication of unexpected good news has proved fatal.

IPECACUANHA. See MATERIA MEDICA.

IPOMOEA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Convolvuli, Jussieu. Essential character: corolla funnel-form; stigma headed globose; capsule three-celled. There are twenty-seven species, of which I. quamoclit, winged-leaved ipomoea is an annual plant, rising with oblong, broad seed leaves, which remain a considerable time before they fall off; stems slender, twining, rising by support to the height of eight feet, sending out several side branches, which twine about each other. The flowers come out singly from the side of the stalks, on slender peduncles an inch long. The tube of the corolla is about the same length, narrow at bottom, and gradually widening to the top, where it spreads open, flat, with five angles. It is of a beautiful scarlet colour, making a fine appearance. It is a native of both Indies.

IRESINE, in botany, a genus of the Dioecia Pentandria class and order. Natural order of Holoraceæ. Amaranthi, Jussieu. Essential character: calyx two-leaved; corolla five-petalled: male, nectary seven: female, stigmas two, sessile; capsule with tomentose seeds. There is only one species, *viz.* I. celosia, a perennial weak plant requiring support, rising twelve feet in height, having large knots at each joint, with oval lanceolate smooth leaves; stems very diffused, branching out on every side; flowers terminating in slender loose panicles, covered with a silky down, of a pale yellow colour. Native of Jamaica and other Islands in the West Indies.

IRIDIUM. Mr. Tennant, on examining the black powder left after dissolving platina, which from its appearance had been supposed to consist chiefly of plumbago, found it contained two distinct metals never before noticed, which he has named iridium and osmium. The former of these was observed soon after by Descostils, and by Vauquelin.

To analyse the black powder, Mr. Tennant put it into a silver crucible with a large proportion of pure dry soda, and kept it in a red heat for some time. The alkali being then dissolved in water; it had acquired a deep orange or brownish yellow colour, but much of the powder remained undissolved. This digested in muriatic acid gave a dark blue solution, which afterward became of a dusky olive green, and finally, by continuing the heat, of a deep red. The residuum being treated as before with alkali, and so on alternately, the whole appeared capable of solution. As some silex continued to be taken up by the alkali, till the whole of the metal was dissolved, it seems to have been chemically combined with it. The alkaline solution contains oxide of osmium, with a small proportion of iridium, which separates spontaneously in dark-coloured thin flakes by keeping it some weeks.

The acid solution contains likewise both the metals, but chiefly iridium. By slow evaporation it affords an imperfectly crystallized mass; which, being dried on blotting-paper, and dissolved in water, gives by evaporation distinct octaedral crystals. These crystals, dissolved in water, produce a deep red solution inclining to orange. Infusion of galls occasions no precipitate, but instantly renders the solution almost colourless. Muriate of tin, carbonate of soda, and prussiate of potash, produce nearly the same effect. Ammonia precipitates the oxide, but, possibly from being in excess, retains a part in solution, acquiring a purple colour. The fixed alkalies precipitate the greater part of the oxide, but retain a part in solution, this becoming yellow. All the metals that Mr. Tennant tried, except gold and platina, produced a dark or black precipitate from the muriatic solution, and left it colourless.

The iridium may be obtained pure, by exposing the octaedral crystals to heat, which expels the oxygen and muriatic acid. It was white, and could not be melted by

any heat Mr. Tennant could employ. It did not combine with sulphur, or with arsenic. Lead unites with it easily, but is separated by cupellation, leaving the iridium on the cupel as a coarse black powder. Copper forms with it a very malleable alloy, which, after cupellation with the addition of lead, leaves a small proportion of the iridium, but much less than in the preceding instance. Silver forms with it a perfectly malleable compound, the surface of which is tarnished merely by cupellation; yet the iridium appears to be diffused through it in fine powder only. Gold remains malleable, and little altered in colour, though alloyed with a considerable proportion; nor is it separable either by cupellation or quartation. If the gold or silver be dissolved, the iridium is left as a black powder.

The French chemists observed, that this new metal gave a red colour to the triple salt of platina and sal ammoniac, was not altered by muriate of tin, and was precipitated of a dark brown by caustic alkali. Vauquelin added, that it was precipitated by galls, and by prussiate of potash: but Mr. Tennant ascribes this to some impurity.

Mr. Tennant gave it the name of iridium from the striking variety of colours it affords while dissolving in muriatic acid.

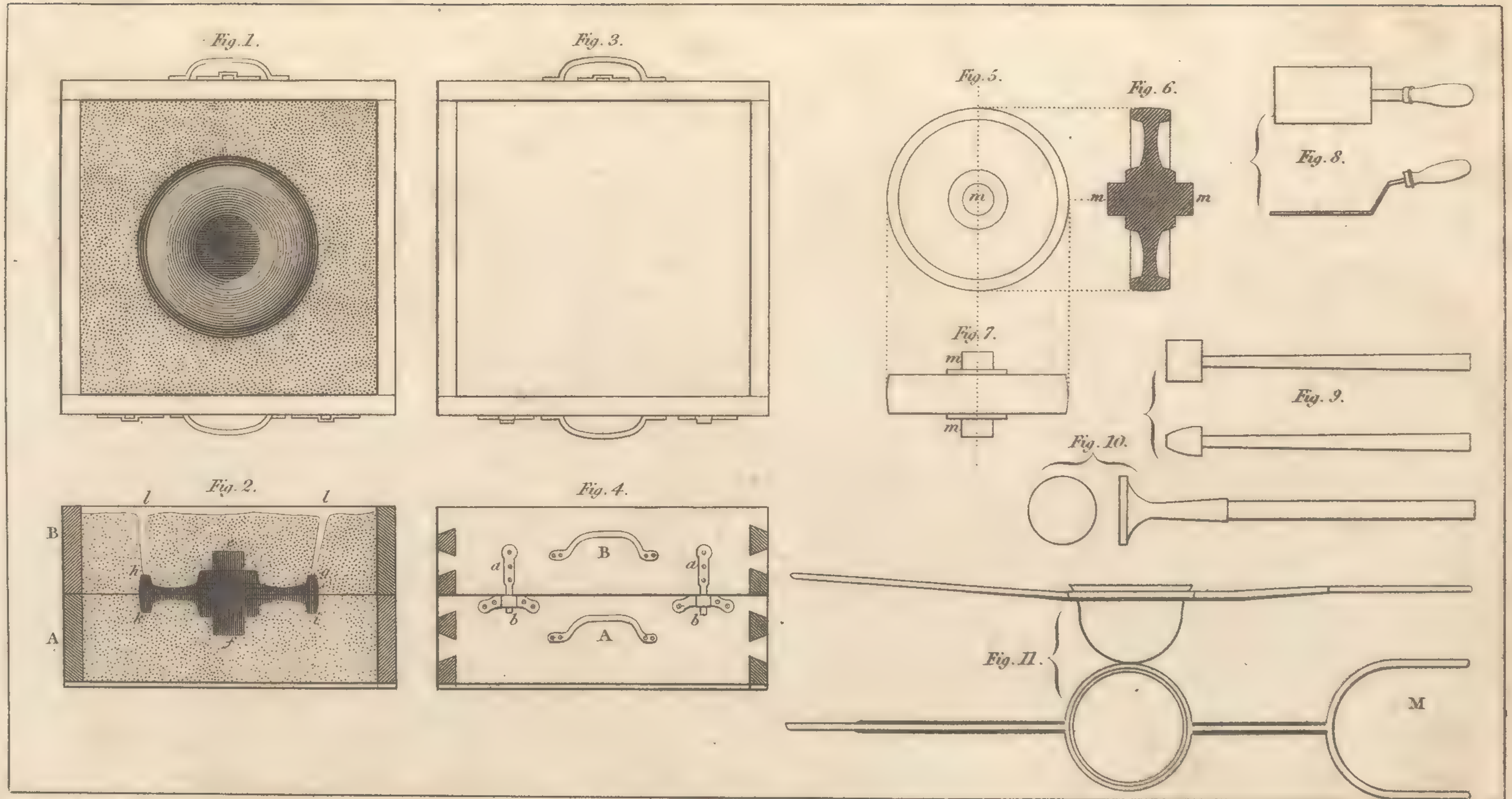
Dr. Wollaston has observed, that among the grains of crude platina there are some scarcely distinguishable from the rest but by their insolubility in nitro-muriatic acid. They are harder, however, when tried by the file; not in the least malleable; and of the specific gravity of 19.5. These appeared to him to be an ore, consisting entirely of the two new metals.

IRIS, in anatomy, the anterior coloured part of the uvea of the eye, so called because of its variety of colours, iris being the Latin word for rainbow. The iris is a circular variously coloured part, which surrounds the pupil; it is in some persons blue, in others black, brown, grey, &c. each of which has its peculiar beauty, and is suited to the complexion of the person who has it. See ANATOMY, OPTICS.

IRIS, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla six-petalled, unequal, petals alternate, jointed and spreading; stigmas petal-form, cowled, two-lipped. There are fifty species. The iris is an inhabitant of every quarter of the world; America, however, produces very few. Several are found natives of the colder regions of Asia, more still of Europe, and most of the Cape of Good Hope. These plants are herbaceous flowering perennials, both of the fibrous, tuberous, and bulbous rooted kind, producing thick annual stalks from three inches to three feet in height, terminated by large hexapetalous flowers, having three of the petals reflexed back and three erect: these are very ornamental plants, appearing in flower in May, June, and July.

IRON is a metal of a bluish white colour, of considerable hardness and elasticity; very malleable, exceedingly tenacious and ductile, and of a moderate specific gravity among metallic substances. It is much disposed to rust by the access of air, or the action of water, in the common temperature of the atmosphere. The appearance of prismatic colours on its polished surface takes place long before ignition; and at so low a temperature, that the slightest coating of grease is sufficient to prevent their appearance by defending it from the contact of air. It may be ignited, or at least rendered sufficiently hot to set fire to brimstone, by a quick succession of blows with a hammer. When struck with a flint, or other hard stone, it emits decrepitating ignited particles, such as can be obtained from no other metal by the same means. These particles are seldom larger than the two hundredth part of an inch in diameter; and, when examined by a magnifier, are found to be hollow, brittle, and of a greyish colour, resembling the scales of burned iron. This metal is easily oxided by fire. A piece of iron wire, immersed in a jar of oxygen gas, being ignited at one end, will be entirely consumed by the successive combustion of its parts. It requires a very intense heat to fuse it; on which account it can only be brought into the shape of tools and utensils by hammering. This high degree of infusibility would deprive it of the most valuable property of metals, namely, the uniting of smaller masses into one, if it did not possess another singular and advantageous property, which is found in no other metal except platina; namely, that of welding. In a white heat, iron appears as if covered with a kind of varnish; and in this state, if two pieces be applied together, they will adhere, and may be perfectly united by forging. Iron is thought to be the only substance in nature, which has the property of becoming magnetical. It is highly probable, from the great abundance

IRON FOUNDRY.



J. Farey Jun^r. delin.

London. Published by Longman, Hurst, Rees & Orme, Sep^t. 1. 1808.

Lowry sculp.

of this metal, that all substances which exhibit magnetism do contain iron; but it must be confessed, that there remain many experiments to be made among the earths and powders which exhibit magnetical properties, before this negative proposition, which confines magnetism to iron, can be admitted as proved.

When iron is exposed to the action of pure water, it acquires weight by gradual oxydation, and hydrogen gas escapes: this is a very slow operation. But if the steam of water be made to pass through a red hot gun-barrel, or through an ignited copper or glass tube, containing iron wire, the iron becomes converted into an oxide, while hydrogen gas passes out at the other end of the barrel. The action of air, assisted by heat, converts iron into a black oxide, containing twenty-five of oxygen. By the action of stronger heat this becomes a reddish brown oxide, containing forty-eight of oxygen. The yellow rust, formed when iron is long exposed to damp air, is not a simple oxide, as it contains a portion of carbonic acid. According to M. Chenevix, there are four stages of oxydation of iron: the first, or minimum, white; the second, green; the third, black; the fourth, or maximum, red. Thenard admits only three, the white, green, and red.

The concentrated sulphuric acid scarcely acts on iron, unless it is boiling. If the sulphuric acid be diluted with two or three parts of water, it dissolves iron readily, without the assistance of any other heat than what is produced by the act of combination. During this solution, hydrogen gas escapes in large quantities.

Sulphate of iron is not made in the direct way, because it can be obtained at less charge from the decomposition of martial pyrites. It exists in two states, one containing oxide of iron, with .27 of oxygen, which is of a pale green, not altered by gallic acid, and giving a white precipitate with prussiate of potash. The other, in which the iron is combined with .48 of oxygen, is red, not crystallizable, and gives a black precipitate with gallic acid, and a blue with prussiate of potash. In the common sulphate these two are mixed in various proportions.

Distillation separates the acid from sulphate of iron, and leaves the brown oxide of iron, called colcothar.

Vegetable astringent matters, such as nut-galls, the husks of nuts, logwood, tea, &c. which contain the gallic acid, precipitate a fine black fecula from sulphate of iron, which remains suspended for a considerable time in the fluid, by the addition of gum arabic. This fluid is well known by the name of ink. See Ink.

The beautiful pigment, well known in the arts by the name of Prussian blue, is likewise a precipitate afforded by sulphate of iron.

If two parts of alum, and one of sulphate of iron, be dissolved in eight or ten parts of boiling water, and a solution of prussiate of potash be added as long as any effervescence and precipitation are produced, the precipitate, thoroughly washed by affusion of boiling water, will have a green colour. This is owing to the yellow oxide of iron thrown down with the prussiate, which must be dissolved by adding muriatic acid. The deep blue powder, insoluble in this acid, is then to be washed and dried for use. According to Professor Proust, the iron in Prussian blue contains .48 of oxygen, and is obtained only from a super-oxygenated sulphate; the precipitate from a pure alkaline prussiate and sulphate of iron with a minimum of oxygen being white, and containing only .27 of oxygen. This may explain a fact observed by a French colourman, who, having mixed some Prussian blue and white lead with nut oil, and set it by for some time covered with water, found the surface only blue, and all the rest white. On pouring it out on his stone, and beginning to grind it afresh, with intention to add more Prussian blue, he found the colour gradually returning of itself. Here it might be supposed that the oxide of the prussiate had parted with oxygen to the oil, or the oxide of lead, or both, thus becoming white; except that on the surface, which was supplied with oxygen from the superincumbent water; and that it recovered its colour by attracting oxygen from the air. But on this supposition it would seem, that light must contain oxygen, since the colour of this paint, spread on wood or paper, returned by exposure to light in vacuo as well as in the open air. The colour of Prussian blue is affected by the contact of iron. Mr. Gill, finding a knife with which he was mixing some Chinese blue acquire a green tinge, spread a little of it, and afterward a little Prussian blue, sufficiently diluted on the blade of a knife, and with a camel hair pencil took off enough to form a tint on paper, and thus continued, till he had taken off in the first instance thirty-six, and in the second eighty-

six, without adding any fresh colour. These tints differed in regular gradation from greenish blue to green, olive green, yellowish green, yellow, and so on to a buff.

Concentrated nitric acid acts very strongly upon iron filings, much nitrous gas being disengaged at the same time. The solution is of a reddish brown, and deposits the oxide of iron after a certain time; more especially if the vessel be left exposed to the air. A diluted nitric acid affords a more permanent solution of iron, of a greenish colour, or sometimes of a yellow colour. Neither of the solutions affords crystals; but both deposit the oxide of iron by boiling, at the same time that the fluid assumes a gelatinous appearance.

Diluted muriatic acid rapidly dissolves iron, at the same time that a large quantity of hydrogen is disengaged, and the mixture becomes hot. In this, as well as in the sulphuric solution of iron, the same quantity of alkali is said to be required to saturate the acid as before the solution; whence it is inferred, that the acid is not decomposed, but that the oxidation is effected by the oxygen of the water; whence also it appears to follow, that the hydrogen must be afforded from the decomposed water, and not from the metal.

Carbonic acid, dissolved in water, combines with a considerable quantity of iron, in proportion to its mass. Vinegar scarcely dissolves it, unless by the assistance of the air.

Phosphoric acid unites with iron, but very slowly. The union is best effected by adding an alkaline phosphate to a solution of one of the salts of iron, when it will fall down in a white precipitate. A saturated phosphate of iron has been found native in France, semi-transparent, of a red brown colour, and foliated texture. A deep blue phosphate of iron, lamellated, and fragile, of the specific gravity of 2.6, brought from the Isle of France, and analysed by Laugier, Fourcroy, and Vauquelin, gave iron 41.25, phosphoric acid 19.25, water 31.25, alumina 5, and ferruginous silex 1.25, in 100 parts. A similar phosphate has been found in Brazil. This acid is found combined with iron in the bog ores, and being at first taken for a peculiar metal was called siderite by Bergman.

Liquid fluoric acid attacks iron with violence; the solution is not crystallizable, but thickens to a jelly, which may be rendered solid by continuing the heat. The acid may be expelled by heating it strongly, leaving a fine red oxide.

Borate of iron may be obtained by precipitating a solution of the sulphate with neutral borate of soda.

Arsenic acid likewise unites with iron. This arseniate is found native in Cornwall, in pretty large cubic crystals, tolerably transparent, of a dark green colour with a brownish tinge; sometimes yellowish, or of a brown yellow, like resin. The Count de Bournon found likewise a cupreous arseniate of iron, in minute rhomboidal crystals of a faint sky blue colour and uncommon brilliancy. Specific gravity 3.4. The green and red sulphates of iron may be decomposed by arseniate of ammonia, and afford arseniate of iron in the two different states.

Chromate of iron is said to have been found abundantly in the department of Var in France, and to form a beautiful green for enamelling or colouring pastes. Its analysis by Vauquelin and Tassaert gave chromic acid 43, oxide of iron 34.7, alumina 20.3, silex 2, in 100 parts.

In the dry way, this metal does not combine with earths, unless it be previously oxided; in which case it assists their fusion, and imparts a green colour to the glass. It appears to combine with alkalies by fusion. Nitre detonates strongly with it, and becomes alkalized.

Sulphur combines very readily with iron, in the dry and even in the humid way, though neither of these substances is scarcely at all soluble in water. A mixture of iron filings and flowers of sulphur being moistened, or made into a paste, with water, becomes hot, swells, adheres together, breaks, and emits watery vapours of an hepatic smell. If the mixture be considerable in quantity, as for example, one hundred pounds, it takes fire in twenty or thirty hours, as soon as the aqueous vapours cease.

By fusion with iron, sulphur produces a compound of the same nature as the pyrites, and exhibiting the same radiated structure when broken. If a bar of iron be heated to whiteness, and then touched with a roll of sulphur, the two substances combine, and drop down together in a fluid state. It is necessary that this experiment should be made in a place where there is a current of air to carry off the fumes; and the melted matter, which may be received in a vessel of water, is of the same nature as that produced by fusion in the common way, excepting that a greater quantity of

sulphur is fused by the contact of the bar of iron. According to Proust the native sulphuret, or pyrites, contains 47.36 per cent. of sulphur, the artificial sulphuret but 37.5. Mr. Hatchett however has found, that the magnetical pyrites contains the same proportion as the artificial sulphuret.

Phosphorus may be combined with iron by adding it cut into small pieces to fine iron wire, heated moderately red in a crucible: or by fusing six parts of iron clippings, with six of glacial phosphoric acid, and one of charcoal powder. This phosphuret is magnetic; and Mr. Hatchett remarks, that iron, which in its soft or pure state cannot retain magnetism, is enabled to do so when hardened by carbon, sulphur, or phosphorus, unless the dose be so great as to destroy the magnetic property, as in most of the natural pyrites and plumbago.

The combination of carbon with iron, is of all the most important, under the names of cast iron and steel. We shall just observe here, that according to Mr. Mushet of the Calder iron-works, who has investigated the subject very extensively in the large way, soft cast steel capable of welding contains $\frac{1}{120}$ of carbon, common cast steel $\frac{1}{100}$, cast steel of a harder kind $\frac{1}{90}$, steel too hard for drawing $\frac{1}{50}$, white cast iron $\frac{1}{25}$, melted cast iron $\frac{1}{20}$, black cast iron $\frac{1}{15}$. He conceives, however, that in steel the carbon is more intimately united with the iron. When iron is saturated with carbon it becomes what is commonly called plumbago.

Iron unites with gold, silver, and platina. When heated to a white heat, and plunged in mercury, it becomes covered with a coating of that metal. Long trituration of mercurial amalgams likewise causes a coating to adhere to the ends of iron pestles; small steel springs, kept plunged beneath the surface of mercury in certain barometers, become brittle in process of time; and the direct combination of iron and mercury in the form of an amalgam may be obtained, according to Vogel, by triturating the filings with twice their weight of alum, then adding an equal weight or more of mercury, and continuing the friction, with a very small quantity of water, till the union is completed. Mr. A. Aikin unites an amalgam of zinc and mercury with iron filings, and then adds muriate of iron, when a decomposition takes place, the muriatic acid combining with the zinc, and the amalgam of iron and mercury assuming the metallic lustre by kneading, assisted with heat. Iron and tin very readily unite together, as is seen in the art of tinning iron vessels, and in the fabrication of those useful plates of iron, coated with tin, which are generally distinguished by the simple name of tin alone. The chief art of applying these coatings of tin consists in defending the metals from oxidation by the access of air. After the iron plates are scraped, or rendered very clean by scouring with an acid, they are wetted with a solution of sal ammoniac, and plunged into a vessel containing melted tin, the surface of which is covered with pitch or tallow, to preserve it from oxydation. The tin adheres to, and intimately combines with, the iron to a certain depth, which renders the tinned plates less disposed to harden by hammering than before; as well as much less disposed to alter, by the united action of air and moisture. The process for tinning iron vessels does not essentially differ from that which has already been described for copper vessels. Iron does not unite easily with bismuth, at least in the direct way. This alloy is brittle, and attractable by the magnet even with three fourths of bismuth. As nickel cannot be purified from iron without the greatest difficulty, it may be presumed that these substances would readily unite, if the extreme infusibility of both did not present an obstacle to the chemical operator. Arsenic forms a brittle substance in its combination with iron. Cobalt forms a hard mixture with iron, which is not easily broken. The inflammability and volatility of zinc present an obstacle to its combination with iron. It is not improbable, however; but that clean iron filings would unite with zinc, if that metal were kept in contact with them for a certain time, in a heat not sufficient to cause it to rise; for it has been found, that zinc may be used in the operation of coating iron in the same manner as tin. Antimony unites with iron, and forms a hard brittle combination, which yields in a slight degree to the hammer. The sulphuret of antimony is decomposed by virtue of the greater affinity of the iron to the sulphur. For this purpose, five ounces of the points of nails from the farriers may be made red hot in a crucible, one pound of pulverized ore of antimony must then be thrown into the crucible, and the heat quickly raised to fuse the whole. When the fusion is perfect, an ounce of nitre in powder may be thrown in, to facilitate the

separation of the scoriæ. After the mass is cooled, the antimony is found separate at the bottom of the crucible, while the iron remains in combination with the sulphur and alkali. If the proportion of the iron be considerably greater than five ounces to the pound of ore, the antimony will be alloyed with iron. Manganese is almost always united with iron in the native state. Tungsten forms a brittle, whitish-brown, hard alloy, of a compact texture, when fused with white crude iron. The habitudes of iron with molybdena are not known.

Iron is the most diffused, and the most abundant, of metallic substances. Few mineral bodies or stones are without an admixture of this metal. Sands, clays, and the waters of rivers, springs, rain, or snow, are scarcely ever perfectly free from it. The parts of animal and vegetable substances likewise afford iron in the residues they leave after incineration. It has been found native, in large masses, in Siberia, and in the internal parts of South America. This metal however in its native state is scarce: most iron is found in the state of oxide, in ochres, bog ores, and other friable earthy substances, of a red, brown, yellow, or black colour. The hematites, or blood stones, are likewise ores with oxide of iron: these are either of a red colour, or blue, yellow, or brown. An iron ore is likewise found, of a blue colour, and powdery appearance. This useful metal is so abundant, that whole mountains are composed of iron stone; whereas other metals usually run in small veins. Besides these ores of iron, which are either nearly pure, or else mixed with earths, as in spars, jasper, boles, basaltes, &c., iron is mineralized with sulphur, as in the pyrites; or with arsenic. The coally iron ores contain bitumen. The magnet, or loadstone, is an iron ore, the constitution of which has not yet been accurately examined. Iron is also found in combination with the sulphuric acid, either dissolved in water, or in the form of sulphate.

To analize the ores of iron in the humid way, they must be reduced to a very subtle powder, and repeatedly boiled in muriatic acid. If the sulphureous ores should prove slow of solution, a small quantity of nitric acid must be added to accelerate the operation. The iron being thus extracted, the insoluble part of the matrix only will remain. Prussiate of potash being added to the decanted solution, will precipitate the iron in the form of Prussian blue. This precipitate, when washed and dried, will be equal in weight to six times the quantity of metallic iron it contains; and from this iron four parts in the hundred must be deducted, to allow for the iron which is contained in the prussiate of potash itself. But as this alkali, and every other preparation containing the prussic acid, does not constantly afford the same quantity of iron, the most exact way, in the use of such preparations, consists in previously dissolving a known quantity of iron in sulphuric acid; and precipitating the whole by the addition of the prussiate of potash. This result will afford a rule for the use of the same alkali in other solutions. For as the weight of the precipitate obtained in the trial experiment is to the quantity of iron which was dissolved and precipitated; so is the weight of the precipitate obtained from any other solution to the quantity of iron sought.

If the iron be united to any considerable proportion of zinc or manganese, the Prussian blue must be calcined to redness, and treated with strong nitric acid, which will take up the oxide of zinc. The manganese may then be dissolved by nitric acid with the addition of sugar; and the remaining iron being dissolved by muriatic acid, and precipitated by subcarbonate of soda, will afford 225 grains of precipitate for every 100 grains of metallic iron.

To examine the ores of iron in the dry way, the only requisite is fusion, in contact with charcoal. For this purpose eight parts of pulverized glass, one of calcined borax, and half a part of charcoal, are to be well mixed together. Two or three parts of this flux, being mixed with one of the pounded ore, and placed in a crucible, lined with a mixture of a little clay and pounded charcoal, with a cover luted on, is to be urged with the strong heat of a smith's forge for half an hour. The weight of the ore, in this experiment, should not exceed sixty grains. Other processes for determining the contents, or metallic product, of iron ores, are instituted by performing the same operations in the small, as are intended to be used in the large way.

In the large iron-works, it is usual to roast or calcine the ores of iron, previously to their fusion; as well for the purpose of expelling sulphureous or arsenical parts, as to render them more easily broken into frag-

ments of a convenient size for melting. The mineral is melted or run down, in large furnaces, from sixteen to thirty feet high; and variously shaped, either conical or elliptical, according to the opinion of the iron-master. Near the bottom of the furnace is an aperture for the insertion of the pipe of large bellows, worked by water or steam, or of other machines for producing a current of air; and there are also holes at proper parts of the edifice, to be occasionally opened, to permit the scoriæ and the metal to flow out, as the process may require. Charcoal or coke, with lighted brushwood, is first thrown in; and when the whole inside of the furnace has acquired a strong ignition, the ore is thrown in by small quantities at a time, with more of the fuel, and commonly a portion of limestone, as a flux: the ore gradually subsides into the hottest part of the furnace, where it becomes fused; the earthy part being converted into a kind of glass, while the metallic part is reduced by the coal, and falls through the vitreous matter to the lowest place. The quantity of fuel, the additions, and the heat, must be regulated, in order to obtain iron of any desired quality; and this quality must likewise, in the first product, be necessarily different, according to the nature of the parts which compose the ore.

The iron which is obtained from the smelting furnaces is not pure; and may be distinguished into three states: white crude iron, which is brilliant in its fracture, and exhibits a crystallized texture, more brittle than the other kinds, not at all malleable, and so hard as perfectly to withstand the file: grey crude iron, which exhibits a granulated and dull texture when broken; this substance is not so hard and brittle as the former, and is used in the fabrication of artillery and other articles which require to be bored, turned, or repaired: and black cast iron, which is still rougher in its fracture; its parts adhere together less perfectly than those of the grey crude iron: this is usually fused again with the white crude iron.

Whenever crude iron, especially the grey sort, is fused again in contact with air, it emits sparkles, loses weight, and becomes less brittle. In order to convert it into malleable iron, it is placed on a hearth, in the midst of charcoal, urged by the wind of two pair of bellows. As soon as it becomes fused, a workman continually stirs it with a long iron instrument. During the course of several hours it becomes gradually less fusible, and assumes the consistence of paste. In this state it is carried to a large hammer, the repeated blows of which drive out all the parts that still partake of the nature of crude iron so much as to retain the fluid state. By repeated heating and hammering, more of the fusible iron is forced out; and the remainder, being malleable, is formed into a bar or other form for sale. Crude iron loses upwards of one fourth of its weight in the process of refining; sometimes, indeed, one half.

Purified, or bar iron, is soft, ductile, flexible, malleable, and possesses all the qualities which have been enumerated under this article as belonging exclusively to iron. When a bar of iron is broken its texture appears fibrous; a property which depends upon the mechanical action of the hammer while the metal is cold. Ignition destroys this fibrous texture, and renders the iron more uniform throughout; but hammering restores it.

If the purest malleable iron be bedded in pounded charcoal, in a covered crucible, and kept for a certain number of hours in a strong red heat, (which time must be longer or shorter, according to the greater or less thickness of the bars of iron) it is found that by this operation, which is called cementation, the iron has gained a small addition of weight, amounting to about the hundred and fiftieth, or the two hundredth part, and is remarkably changed in its properties. It is much more brittle and fusible than before. Its surface is commonly blistered when it comes out of the crucible; and it requires to be forged to bring its parts together into a firm and continuous state. This cemented iron is called steel. It may be welded like bar iron if it have not been fused or over-cemented; but its most useful and advantageous property is that of becoming extremely hard when ignited and plunged into cold water. The hardness produced is greater in proportion as the steel is hotter, and the water colder. The colours which appear on the surface of steel slowly heated are yellowish-white, yellow, gold colour, purple, violet, deep blue; after which the ignition takes place. These signs direct the artist in tempering or reducing the hardness of steel to any determinate standard. If steel be too hard it will not be proper for tools which are intended to have a fine edge, because it will be so brittle that the edge will soon become notched; if it be too soft it is evident that the edge

will bend or turn. Some artists ignite their tools and plunge them into cold water; after which they brighten the surface of the steel upon a stone: the tool being then laid upon charcoal, or upon the surface of melted lead, or placed in the flame of a candle, gradually acquires the desired colour; at which instant they plunge it into water. If a hard temper be desired the piece is dipped again, and stirred about in the cold water as soon as the yellow tinge appears. If the purple appear before the dipping, the temper will be fit for gravers, and tools used in working upon metals; if dipped while blue it will be proper for springs, and for instruments used in the cutting of soft substances, such as cork, leather, and the like; but if the last pale colour be waited for, the hardness of the steel will scarcely exceed that of iron. When soft steel is heated to any one of these colours, and then plunged into water, it does not acquire nearly so great a degree of hardness as if previously made quite hard, and then reduced by tempering. The degree of ignition required to harden steel is different in the different kinds. The best kinds require only a low red heat. The harder the steel the more coarse and granulated its fracture will be; and as this is not completely remedied by the subsequent tempering, it is advisable to employ the least heat capable of affording the requisite hardness. It is a circumstance worthy of remark, that steel has a less specific gravity when hardened than when soft; but there are no circumstances upon which a probable connection between these two properties, namely, the increased hardness and the diminished specific gravity, can be made out.

If the cementation be continued too long the steel becomes porous, brittle, of a darker fracture, more fusible, and incapable of being forged or welded. On the contrary, steel cemented with earthy infusible powders is gradually reduced to the state of forged iron again. Simple ignition produces the same effect; but is attended with oxidation of the surface. The texture of steel is rendered more uniform by fusing it before it is made into bars; this is called cast steel, and is rather more difficultly wrought than common steel, because it is more fusible, and is dispersed under the hammer if heated to a white heat.

The conversion of iron into steel, either by fusion, *viz.* the direct change of crude iron into steel, or by cementation of bar-iron, present many objects of interesting inquiry. From various experiments of Bergman it appeared, that good crude iron, kept for a certain time in a state of fusion, with such additions as appeared calculated to produce little other effect than that of defending the metal from oxidation, became converted into steel with loss of weight. These facts are conformable to the general theory of Vandermonde, Monge, and Berthollet: for, according to their researches, it should follow that part of the carbon in the crude iron was dissipated, and the remainder proved to be such in proportion as constitutes steel. The same chemist cemented crude iron with plumbago, or carbonate of iron, and found that the metal had lost no weight. Morveau repeated the experiment with grey crude iron. The loss of weight was little, if any. The metal exhibited the black spot by the application of nitric acid, as steel usually does, but it did not harden by ignition and plunging in water. Hence it is concluded, that it was scarcely altered: for crude iron also exhibits the black spot, and cannot by common management acquire the hardness of steel.

From the experiments of the three excellent chemists last mentioned, it appears, that the grey crude iron consists principally of iron, with as much carbon as it can dissolve in the strong heat of the smelting furnace. They have shown also, that it deposits part of this addition when cooled in contact with an iron bar immersed in the bath. This separation must be general in the ordinary or gradual way of cooling, whence the grey colour must arise from the blue white colour of the iron mixed with the black of the carbon. And this grey colour is also in a degree perceived, when soft close-grained steel is broken. These circumstances lead to an inference, that hard steel may in a certain respect differ from that which is softer by the intimate combination of a larger proportion of carburet. This accounts for the whiter and more metallic aspect of hardened steel, than of such as is soft. For the former contains less of disengaged carburet. Hence also we may account for the greater hardness of steel, which has been made quite hard, and then let down by tempering to a certain colour, than of steel merely heated to that colour, and plunged in water. For in the first method of hardening, a sufficient degree of heat is given to produce combination between part of the disengaged

carburet and the iron, which in the latter does not take place. If the carburet be merely sufficient to saturate all the iron at a moderate degree of ignition, the hardness will be considerable; but the steel will be easily degraded to the state of iron by frequent ignition. Such steel in its hard state will be very uniform in its texture, not excessively hard in its temper, but disposed to take a very fine firm edge, which will not easily be broken or injured by violence. These are accurately the properties of the English cast steel, which is of so uniform a nature, as to be distinguished by its conchoidal or glassy fracture. When the dose of carbon in steel is greater, it will bear a greater heat without degradation, insomuch that it may be welded like iron. Its hardness will also be capable of a higher degree; and if this degree produced by a stronger ignition be not given, the edge of the tool will never become fine and smooth; and even at this higher degree, with all the advantage of subsequent tempering, it will be less smooth than that of the cast steel, and more disposed to break. Steel of this kind is better adapted for the construction of hammers, vices, hatchets, leather-cutters' knives, and other instruments wherein the edge is either stout, or sudden blows unnecessary, or the construction demands frequent heating and welding.

By pursuing this train of reflection, it will follow, that, since crude iron dissects from steel only in the superabundance of carbon, it ought to be capable of extreme hardness, if ignited to that degree which is requisite to combine the greater part of this carbon with the iron, and then suddenly cooled. This is accordingly found to be the case. If the grey crude iron, commonly distinguished by our founders by the name of soft metal, be heated to a white heat, and then plunged into water, it becomes very hard, much whiter, denser, and more metallic in its appearance; and will bear a pretty good edge, fit for gravers, for the use of turners in iron or steel. In these tools the angle of the planes which form the edge is about 45°. The hardness of this kind of iron is not considerably diminished but by ignition continued for a length of time, which is a fact also conformable to what happens in steel. For the cast steel will be softened nearly as much by annealing to the straw colour, as the harder steels are by annealing to a purple or full blue.

Some of our artists have taken advantage of this property of soft crude iron in the fabrication of axles and collars for wheel-work; for this material is easily filed and turned in its soft state, and may afterward be hardened so as to endure a much longer time of wear.

The founders who cast wheels and other articles of mechanism are occasionally embarrassed by this property. For, as the metal is poured into their moulds of moistened sand, the evaporation of the water carries off a great portion of the heat, and cools the iron so speedily, as to render it extremely hard, white, and close in its texture. This is most remarkable in such portions of the metal, as have the greatest distance to run from the git or aperture of reception. For these come in contact successively with a larger portion of the sand, and are therefore more suddenly cooled. We have seen the teeth of cog-wheels altogether in this state, while the rim and other parts of the wheel remained soft. The obvious remedy for this defect is to increase the number of gits, and to have the sand as dry as possible or convenient. In other articles this property has been applied to advantage, particularly in the steel rollers for large laminating mills, which Messrs. Vandermonde, Monge, and Berthollet have supposed to be an overcemented steel. They are made by casting the grey crude iron in moistened sand, the contact of which gives the hard steel temper to the outside surface, for the depth of more than half an inch. There is no doubt, but that the iron-masters pay considerable attention to the quality of the iron, and perhaps to the degree of heat and moisture of the sand in this operation, in order that the hardness may be such as to yield to the turning tool; and it is likewise understood, that a considerable number crack longitudinally in the cooling, a loss which in all probability arises from the difference of contraction between the hard and soft parts.

A variety of facts concerning the hardening and softening of steel are collected by Guyton Morveau, the most interesting of which shall be here subjoined. According to Reaumur, that part of the steel which was hottest at the time of immersion in the water will be the hardest; whence it has been thought a fair conclusion, that the hardness of steel is the greater, the stronger the ignition, and the more speedy the cooling. Nevertheless, the celebrated Rinman deduces a very different consequence; name-

ly, that the steel which is naturally the hardest is that which requires the least heat, and that the best temper for each kind of steel is that produced by the lowest degree of heat suitable to that peculiar kind. Hence, various methods have been proposed to ascertain the degree of heat most advantageous to any particular sample of steel. They are all reducible to that of igniting one end of a bar to a white heat, and plunging it into water. The hardness of the several parts may then be ascertained by examination.

It appears that the considerations on which the first-mentioned general rule is founded, are rather of a complicated nature. If it be true, as conjectured above, that the hardness of steel depends principally on the intimate combination of its carbon; it will follow, that the utmost hardness any steel is capable of, will be produced by a degree of heat sufficient to effect this purpose, and that any superior degree will only degrade the quality of the steel; and consequently, that the general rule will apply only to heats inferior to this maximum. It may also happen, when the mass of water is not considerable, though the fact has been doubted, when the quantity is large, that the heating of the water, and the production of hydrogen, may so far modify the rate of cooling, as even to render it less sudden than might have happened with an inferior degree of ignition. Lavoisier has remarked, that the conversion of iron into the hard brittle oxide, when water is decomposed, may perhaps be of the same nature as the hardening of steel. There is another fact, which is of great consequence, and may perhaps afford the principal ground for Rinman's apparent exception to the general rule concerning the hardening of steel. Hardness is that property of bodies by which they resist indentation, and rather break than bend or suffer contusion. It is the opposite to softness. Tenacity, which is very frequently confounded with hardness, is not the property by which they resist indentation, but separation of their parts. It is the opposite to friability or brittleness. Now that steel, in common language, is said to be the hardest, which unites most eminently the properties of hardness and tenacity. But the effect of heat and sudden cooling is directly opposite in these two respects. Soft steel is the most tenacious, but the least hard. The operation of hardening diminishes its tenacity, and increases its hardness progressively to the maximum of heat the steel is formed to bear. There will be no difficulty then in conceiving, that the best state of steel, relative to any particular use, will be at some precise degree between the softest and hardest qualities. Thus for springs, much tenacity and moderate hardness are required. For chissels and similar tools, which operate by a blow, a greater hardness may be admitted. Razors, knives, and such tools as effect the intended purpose by a gradual stroke, will be still more valuable the harder they are; but even in these the tenacity must not be too much diminished, otherwise the edge will be liable to break. They must all be capable of having the edge turned or bended on one side in the operation of whetting. Files are perhaps of all tools such as require the greatest hardness; but in these, it is far from being the utmost the steel is capable of receiving. It is found, that the tenacity of steel is considerably increased by continued hammering to a certain point. But the whole effect of this hammering is taken off by strong ignition. Good steel by hardening at a white heat may be rendered so brittle, that it will break full as easily as a stick of the same dimensions, and its texture is then found to be coarse and large grained. As the subsequent annealing does not restore the effect of the hammering, nor bring the grain of the steel to the state it would have possessed if a lower heat had been used at first; it is evident, that the most useful hardness is produced by that degree of heat, which is just sufficient to effect the purpose. And accordingly, tools made of cast steel, and intended to sustain a good edge for cutting iron and other metals, are not afterward annealed, but the ignition is carefully regulated at first. Annealing ought only to be used where considerable softness is required.

Iron may be hardened to a certain degree by ignition and plunging in water, but this effect is confined to the surface; except, as it very often happens, the iron contains veins of steel. These are no small impediments to the filing and working this material. It sometimes likewise may happen, that the iron may have undergone a process of the nature of case-hardening from the fuel. We have been informed by a workman, that ignited iron, suddenly plunged into the soft leather of a shoe, becomes very hard on its surface, which must arise from an instantaneous effect of this kind.

The increase of dimensions acquired by steel in hardening is such, that in general such pieces of work as are finished soft will not fit their places when hardened. Rinman found, that bars of steel six inches long, six lines wide, and half an inch thick, were lengthened at least one line after hardening by a whitish red heat, which is about one seventieth of the linear dimensions; and supposing the dilatation to be proportional, Guyton Morveau computes the bulks to be as 48 to 49. But the cubes of 72 lines and 73 lines are in proportion more nearly as 47 to 50. Various kinds of steel at different hardness must no doubt greatly differ in this respect. The specific gravities, as given by Brisson, p. 366, art. GRAVITY (*specific*), afford a much less ratio. Rinman found by his experiments on two different kinds of fine cemented steel, the specific gravity of which was 7.991, that one after hardening gave only 7.553, and the other 7.708. These numbers agree sufficiently near with the experiment of the six-inch bar. Yet he once found Styrian steel augmented in density by hardening in the ratio of 7.822 to 7.782. Morveau found, with pieces of steel 28 lines long, that the increase of length by hardening was about the 350th part.

The fineness of grain in hard steel, as exhibited in its fracture, is various, according to the quality of the metal, and the temper it has received. The harder the steel the coarser the grain. But in like circumstances, fine steel has the closest grain, and is ever the most uniform in its appearance. Workmen avail themselves much of this indication. In general a neat curve lined fracture, and even grey texture, denote good steel; and the appearance of threads, cracks, or brilliant specks, denotes the contrary. But the management of the forging and other circumstances of manufacturing will modify these indications; and the steel that is good for some purposes may be less suited to others.

The fluid into which ignited steel is plunged is of great consequence. All the facts seem reducible to these general conclusions. The hardness will be greater, 1. The hotter the steel is made, provided it be not decomposed: 2. The more considerably its temperature is lowered in the cooling: 3. The shorter the time of cooling: and 4. The more favourable the fire or the cooling material may be to the steel-making process. But the most useful combination of hardness and tenacity will be at a medium temperature in each kind of steel.

With regard to the first particular, little need be said, but that the decomposition of steel in heating will be prevented, and its surface somewhat improved, if it be bedded in charcoal, or the cementing compound, during the application of the heat. The second and third, namely the quantity and suddenness of cooling, require an attention to the doctrine of CALORIC, as explained under that article. The cooling will be more sudden and effectual the greater the quantity of heat absorbed in the same time. There are three circumstances which favour this effect, namely, a very low temperature of the body to which the hot steel is applied; that it should be a good conductor of heat; or that it shall assume either the fluid or elastic state, which always demand a supply of heat for their maintenance. Thus it is found, that steel is more effectually hardened in cold than in warm water, and at like temperatures more effectually in mercury than in water. It may also be remarked, that these two fluids cool the steel by different energies. The water is partly converted into vapour, which carries off the heat, and leaves the fluid much less altered in temperature than mercury, which acts by its conducting property. This last fluid, not having evaporated in the process, is found to have acquired a much more elevated temperature by the immersion. Oil is found to harden the surface of steel much more than its internal part, so that it resists the file, but is much less easily broken by the hammer. This effect arises from its imperfect conducting quality, and the elevated temperature it demands to be converted into the vaporous state; to which we may also add, that a stratum of coal is formed round the steel from the burned oil, which still more effectually prevents the transmission of the heat. A remarkable instance of this nature presented itself to our observation in hardening a small piece of steel two inches long, and a quarter of an inch diameter. At the time of ignition, the water nearest at hand had been used with soap. The steel made very little noise when plunged into the water, and remained hot for a considerable time; but when taken out was found to be scarcely at all hardened. It was covered with coally matter; which being cleared off, and the process repeated with clean water, it

became perfectly hard. The heat in both cases was a low red heat, proper for cast steel, which is not intended to be afterwards annealed. We have very little doubt, but that alcohol and the essential oil of turpentine, which are good conductors of heat and very volatile, would render steel very hard, if their inflammability, and the little necessity there is for using them, were not an impediment to their application. Various artists avail themselves of different substances for the immersion of ignited steel. Some use urine, others water charged with common salt, nitre, or sal ammoniac. Tallow and oil are used for such works as are not required to be brittle, though very hard, the reason of which has just been mentioned; but tallow differs from oil in the heat which becomes latent for its fusion; and accordingly, solid tallow is an excellent material for hardening drills and other small articles. It has been found by Reaumur, that saline liquids produce rather more hardness than common water; and in particular, that aquafortis possesses this property in an eminent degree, probably from its conducting power: the makers of files cover them with the grounds of beer and common salt, which assist their hardening, and keep the surface from scorifying. The mucilage of the beer supplies a coally matter; and the fused salt seems not only to form a varnish in the fire and defend the steel, but may also produce cold, by its sudden solution in the water at the time of immersion. Very small articles heated in a candle are found to be hardened perfectly by suddenly whirling them in the cold air; and thin bars or plates of steel, such as the magnetic needle of a compass, acquire a good degree of hardness by being ignited, then laid on a plate of cold lead, and suddenly covered with another plate. These would be unequally hardened, and bend, if plunged in water.

The *bluing* of steel appears to affect its elasticity in a manner not easily explained. This operation consists in exposing steel, the surface of which has been first brightened, to the regulated heat of a plate of metal, or a charcoal fire, or the flame of a lamp, till the surface has acquired a blue colour. Now, if this blue coal be removed by grinding, the elasticity is completely destroyed, and may be restored by bluing the steel again. Rubbing with sand or emery-paper, glazing, or burnishing, equally impairs the elasticity in proportion as it destroys the blue coat. Saw-makers first harden their plates in the usual way, in which state they are brittle and warped: they then soften them by blazing, which consists in smearing the plate with oil or grease, and heating it till thick vapours are emitted, and burn off with a blaze; and after this they may be hammered flat; lastly, they blue them on a hot iron, which renders them stiff and elastic without altering their flatness.

The Damascus sword-blades have long been celebrated for their excellence, but it is not known how they are made. Mr. Stoddart took six small bars of good malleable iron, and the same number of sheer steel; laid them alternately on each other; welded them together; forged them into a stout flat plate, which was twisted spirally into a cylinder, hammered flat, and again welded; hammered this flat, doubled it throughout its length, inserted in the fold a slip of good steel to form the edge, and by another welding heat consolidated the whole into one mass. This being forged to a proper shape, cracked in different places on being cooled in water after heating: but Mr. Stoddart conceives, that by using more pieces, repeating the twisting, and not quenching in water, the process would succeed.

Every species of iron is convertible into steel by cementation; but good steel is not to be made except from iron of the best quality, which possesses a certain stiffness and hardness as well as malleability. Swedish iron, as we have before remarked, is the best for this purpose. M. Duhamel tried a great number of the irons of France, Sweden, and Spain. He found the second to be the best; but he likewise obtained excellent steel, superior to those of Styria and Carinthia, which are the best German steels, by using certain iron made in France. But this iron was selected without fault; and, in some instances, the loup or piece at the smelting furnace was fused and forged a second time, a process which, though attended with loss of weight and additional expense, he recommends as absolutely necessary for making steel iron from ores of indifferent quality. The white spathose iron ores afforded him the best iron for the purpose of cementation; and these also are the ores which afford the best steel by fusion in Styria, Carinthia, and Tyrol. He informs us that the English use no other cement than mere charcoal, which he also finds perfectly adequate to the purpose; and, moreover, that the quality of the steel is

not affected by the different kinds of charcoal made use of. He remarks, nevertheless, that it may be advisable to add from one-fourth to one-third of wood ashes, especially where the iron is not of so good a quality as to afford steel possessing tenacity of body, as well as hardness. These ashes, which he used with success, prevent the steel-making process from being effected as rapidly as it would otherwise be, and give the steel pliability without diminishing its hardness. It is remarked, that in the case of this management, the blisters on the surface of the steel are smaller and more numerous. He likewise tried sea-salt. Fifty pounds of salt are sufficient for a furnace of steel of twelve thousand weight. The salt is pulverized, and sprinkled on the bars of iron when put into the furnace. He found that this ingredient likewise contributes to give body to the steel. In the arrangement of the bars in the furnace, the cement is laid one inch thick at the bottom, and half an inch thick between each layer of iron. Our author affirms, that the process would succeed equally well if the thickness were a little more than a quarter of an inch. The thickness of the bars of iron is indifferent, but there ought not to be a great difference in this respect between bars cemented at the same time. The common thickness is a little more than half an inch. It is not advisable that they should be very broad in proportion to the thickness, as this figure is found to produce flaws and cracks in the direction of the length of the bar. The bars may be square, or their breadth may conveniently be somewhat more than twice their thickness. The fire for cementation must be of considerable intensity, and kept up until the conversion has perfectly taken place, which is ascertained by proof bars, so disposed as to be taken out from time to time. The cementation is finished on the sixth day; that is to say, it commonly lasts five times four-and-twenty hours. And accordingly, the workmen take one of the proofs out on the fifth day, which is forged, hardened, and examined by the fracture. If it break short, and show no indications of iron, the fire of the furnace is suffered to go out. But if it contain iron, the fire is kept up for twelve or twenty-four hours, accordingly as the quantity of fibrous iron may have proved greater or less in the first proof. A second proof bar taken out at the proper time serves to direct them in the same manner with regard to their operations. By this management the cementation is continued somewhat beyond the time requisite for the entire conversion. For there is less inconvenience attending a slight degree of excess in the cementation, than would result from a portion of iron remaining in the steel. The charcoal after cementation is as black, and apparently in the same state, as it was before. M. Duhamel moistened it, and applied it to the same use a second time: it answered the purpose, but so much more slowly that he objects to the use of it in manufactories. From this, as well as other circumstances attending the steel-making process, it seems advantageous, at least with regard to expedition, that the coals should contain volatile matter. And hence the superior advantages of animal coal, such as the coal of leather, or the hoofs and horns of animals, imperfectly burned, which are used in case-hardening, though they may be less applicable to the longer process of steel-making for various reasons.

M. Duhamel advises to have two tilting hammers; one of the weight of one hundred and fifty pounds, and the other half that weight; the first for the purpose of forging large works, and the latter small bars for cutlers. He recommends another small hammer of about twelve pounds for forging bars still smaller, to make gravers, small files, and the like. The steel must not be heated beyond the degree of cherry-red for forging. The tilting hammers should give at least three hundred strokes in a minute.

The cast steel of England is made as follows; a crucible about ten inches high, and seven in diameter, is filled with ends and fragments of the crude steel of the manufactories, and the filings or fragments of steel works. They add a flux, the component parts of which are usually concealed. It is probable, however, that the success does not much depend upon this flux, which, from the quality of the cast steel itself, may be presumed to be of the nature of a steel cement. This crucible is placed in a wind furnace like that of the founders, but smaller, because intended to contain one pot only. It is likewise surmounted by a cover and chimney to increase the draught of air. The furnace is entirely filled with coke or charred pit-coal. Five hours are required for the perfect fusion of the steel. It is then poured into long square, or octagonal moulds, each composed of two pieces of cast iron fitted together. The ingots, when taken out of the moulds, have the appearance of cast iron. It is then forged in the same manner as other steel, but with less

heat and more precaution, because more liable to break.

This cast steel is almost twice as dear as other good steel. M. Duhamel says that it is not proper for all kinds of work, particularly those which require much tenacity, as well as hardness to resist violent blows and strains; but it is good for razors, knives, and all toys and small work which require an exquisite polish. It does not seem, however, that the tenacity of this steel is inferior to that of the best of the other kinds, and its uniformity of texture is for many works an invaluable advantange. It is daily more and more used in England, but must necessarily be excluded from many works of considerable size, on account of the facility with which it is degraded in the fire, and the difficulty of welding it, which cannot be done in the common way. We have been informed that the faces of anvils and broad hammers, for the use of silversmiths and other artists, have been made of cast steel, and welded to iron by a particular management, which consisted in substituting between the iron and the steel another kind of steel in the form of filings, or a thin plate. The steel plate intended for the face was made as hot as could be done with safety, and the iron being at the same time brought to the welding heat, was applied to the steel, and quickly united by hammering.

When we consider the operations by which crude iron is brought into the malleable state, then converted into steel, and afterward into a fusible metal, which is not malleable; we may perceive that steel-making is a kind of inversion of the process of refining iron, as practised in the first instance. When the oxide of iron is mixed in the smelting furnace with combustible matter and glass, it will either be completely or partially revived, according to the management of the process. Much of the coal will however be so enveloped with the vitreous matter as to remain unburned: and the reduced iron, with which it may be in contact, will be in the same situation as forged iron in the cementing pot; that is to say, it will be in contact with coal at a very elevated temperature, and defended from the air. From the great infusibility of iron, it may reasonably be concluded, that the reduced metal does not flow into the bottom of the furnace, until the charcoal has converted it into a fusible matter similar to steel, by the same action which takes place in cementation, whatever that action may be. Hence it must follow, that the various specimens of crude or cast iron will differ in their qualities, as well on account of the degree of cementation they have undergone, as the degree of reduction which has taken place among the metallic parts, which are carried down, and form the whole mass. Since the coal, in the process of cementation, communicates or adds weight to the iron; and since crude iron, as well as steel, exhibits sparkles, and is more easily burned than other iron; it may therefore be concluded, that in the process of refining, that part of the inflammable substance which had united with the metal is burned, and leaves the iron much less fusible than before. Stirring the mass multiplies the contacts of the air with the burned substances; these surfaces of contact will therefore successively afford thin coats of infusible metal. In this manner it is found, that, if a large piece of crude iron be exposed to heat in a wind furnace, the external part will be deprived of its fusibility during the time required to produce a strong heat in the whole mass; and the internal part will be melted, and run out, leaving the shell behind. Iron, which is of the consistence of paste, may therefore be considered, like any other paste, as a mixture of a fluid with a solid. It will be easily understood, that the forging will bring the parts of difficult fusion together, and extrude the less refined and fluid parts: it will also be evident, that this operation is not likely to drive out the whole of the fusible matter. When the iron has arrived at that state, wherein the quantity of fibre or tough iron is sufficient to answer the mechanical purposes to which it is intended to be applied, the artist will consider it as sufficiently refined; and the residue of fusible iron contained in the bar, answers, in all probability, the valuable purpose of connecting these infusible masses together. Thus we find that forged iron appears as if covered with a varnish, when urged to a white heat; we find that this varnish is more abundant in steel; and that iron and steel may be respectively welded together by application in this state; an effect which it would be very difficult to account for, in this most infusible of metals, if it were not for such an admixture. But cast steel, steel over cemented, and crude iron, appear to be in the state of all other metals, platina excepted. They cannot be welded, because welding implies a partial fusion: or an effect similar to the gluing or uniting of

solids by the application of a fluid, which afterward becomes consistent. And as platina possesses this valuable property, it seems reasonable to infer, that it must also consist of two metallic substances of different degrees of fusibility; a supposition that appears to be confirmed by the discoveries of Dr. Wollaston and Mr. Tennant.

Crude iron, and steel of a uniform texture, consist therefore of a fusible combination of iron with the combustible substance of the coal, or something which is imparted from it; the crude iron differing from the steel simply in being overdosed with carbon, and less pure, on account of the admixture of metallic oxide, which can scarcely, perhaps, be avoided in the large process. It appears therefore, that crude iron must pass through the state of steel, before it can become forged iron; and consequently, that the fabrication of steel from this last is a circuitous process, which can only be repaid by the absence of those unreduced parts, which may exist in the crude iron. At some forges, however, where the ore, the flux, the fuel, and the management, are adapted to each other, the produce affords steel, when duly refined. At other manufactories, the crude iron is either refined, or converted into steel, by running it into thin plates, which are stratified with charcoal, and burned in a close furnace. In this way the metal is refined by degrees, without undergoing fusion; and if the heat be raised to that of cementation, the iron will not only be reduced, but converted into steel. In the forges of Carinthia the grey crude iron is also converted either into soft iron, or steel, according to the management of a somewhat similar process. The iron is fused in a large melting-pot; and a small quantity of water, being thrown upon the surface of the metal, causes a thin plate to congeal, which is taken off; and by continuing the operation, the greatest part of the fused iron becomes converted into plates. To produce steel, these plates are again fused, and kept a long time in an elevated heat; at the same time that the metal is defended from the contact of the air by a sufficient quantity of the vitreous slag. To produce soft iron, the plates are exposed to a continued roasting, while the air is constantly renewed by means of two pair of bellows. The extensive surface of the plates renders it unnecessary to use that agitation, or stirring, which is required when fused crude iron is refined. In these processes it is evident, that the same matter in the crude iron, which it obtained in the smelting furnace, is employed, and supplies the place of the charcoal used in forming steel by cementation; and on the other hand, that this substance, which prevented the crude iron from being soft, tough, and infusible, is burned away, together with a portion of the iron itself, while the remainder is left in a much purer state.

These are facts observed at the furnaces. But the observations and inquiries of the chemist must be carried further, in order to determine what it is that iron gains or loses at the time of its conversion into its various states. It is found, that crude iron approaches towards the soft state, not only by heating with exposure to the air, which burns the combustible addition, but likewise by fusion, without the free access of air. In this case, when the fusion has been complete, and the cooling gradual, it is found that a black substance is thrown up to its surface, which is more abundant the greyer or blacker the iron; and the same black substance is observed to coat the ladles of forged iron, which are used to take out the metal, and pour it into moulds for casting shot, and other articles. It appears, therefore, that the heated iron, like other heated fluids, is capable of holding a larger quantity of matter in solution than when cold; and that a portion of this black substance separates during the cooling, whether by the gradual effect of surrounding bodies, or by the contact of the ladle, in the same manner as various salts are separated, in part, from water, by a diminution of temperature. From chemical analysis, as well as from its obvious characters, this black substance is found to be plumbago, or the materials used to make pencils, and commonly known by the name of black lead, which is nothing but a carburet of iron.

The presence of this black matter is likewise exhibited by dissolving steel, or crude iron, in acids, in which plumbago is insoluble, and therefore remains behind in the form of a powder. Hence likewise is deduced the cause of the black spot which remains upon steel, or crude iron, after its surface has been corroded by acids; for this spot consists of the plumbago, which remains after the iron has disappeared by solution.

Solution in the sulphuric or muriatic acid not only exhibits the plumbago contained in iron, but likewise possesses the advantage of showing the state of its reduction by the quantity of hydrogen gas which is disen-

gaged: for the quantity of this gas, in like circumstances, is proportional to that of the iron which is converted into oxide. There are considerable differences between the various products of the smelting furnace in these respects; but it is found, that the white crude iron affords the least quantity of hydrogen in proportion to its bulk, and leaves a moderate portion of plumbago; the grey crude iron affords more hydrogen, and more plumbago than the white; and the softest bar iron affords most hydrogen of any, and little or no plumbago. The quantities of hydrogen gas, at a medium, by ounce measures, were sixty-two, afforded by one hundred grains of the white crude iron: seventy-one by the grey crude iron; and seventy-seven by the malleable iron.

Hence it may be inferred, that, in the white crude iron, the processes of reduction and cementation are both carried to a less extent than in the grey crude iron, which is produced by means of a stronger heat, excited with a larger quantity of fuel: and that the reduction of grey crude iron is still less perfect than that of the soft bar iron; though this last, by the refining in an open vessel, is so far from being more cemented, that it scarcely contains any plumbago at all.

It must be admitted, however, that the solution in acids serves only to support these general conclusions, in conjunction with the facts observed in the dry processes; but cannot accurately show the quantities either of hydrogen or plumbago afforded by the several kinds of iron. For the plumbago, as it becomes disengaged, floats on the top of the sulphuric acid; where it gradually disappears, though insoluble in that acid. It must therefore be taken up by the hydrogen gas, and it is found that the volume of this air is diminished by the absorption. Hence there is a double source of inaccuracy from the loss of plumbago, and the contraction of the hydrogen gas.

On the whole then, since iron contains carburet in a state of combination, of which it may be deprived by heat with access of oxygen, which converts its carbon into the carbonic acid; and since it recovers the plumbago by cementation with charcoal; there can be no question, but that this substance is originally afforded by the fuel. It appears also, that the reduction of the metallic oxide takes place first at a lower temperature; and that the combination of the carbon follows at a greater heat. Whence, in the refining of iron, the carbon is first burned, and the iron remains reduced; and in the cementation of bar iron, the metal is converted into steel, with blisters on its surface; which most probably arise from carbonic acid, formed by the oxygen of some portions of unreduced oxide uniting with the acidifiable base from the charcoal. And lastly, as iron holds this acidifiable base, or carbon, in solution, so likewise it may not be separable from this metallic solvent, without carrying a portion with it; in the same manner as salts, which crystallize in water, always take up part of the solvent in the formation of their crystals.

It would require many volumes to enumerate the leading uses of iron. This most valuable of metals is applied to so many, and such important uses, that we cannot look round us without seeing its effects. When we contemplate the innumerable effects of human industry, and ask ourselves the simple question, Could this have been done without iron? There is not a single instance, which will not immediately show its value.

Iron is one of the principal ingredients for dying black. The stuff is first prepared with a bath of galls and logwood, then with a similar bath to which verdegris is added, and lastly dyed in a similar bath with the addition of sulphate of iron. If it be wished, that the colour should be particularly fine, the stuff should previously be dyed of a deep blue: otherwise a brown may be first given with the green husks of walnuts. Silk however must not be previously blued with indigo, and sumach may be substituted instead of galls. Leather, prepared by tanning with oak bark, is blackened by a solution of sulphate of iron.

Cotton has a very strong affinity for oxide of iron, so that, if it be immersed in a solution of any salt of iron, it assumes a chamois colour, more or less deep, according to the strength of the solution. The action of the air on the oxide of iron deepens the colour; and if the shade were at first deep, the texture of the stuff is liable to be corroded by it. To prevent this, the cotton should be immersed in the solution cold, carefully wrung, and immediately plunged into a ley of potash mixed with a solution of alum. After having lain in this four or five hours, it is to be wrung, washed, and dried.

Mr. Brewer, to give a nankeen colour,

prepares his cotton yarn by boiling it five hours in a mixture of water made grass green with sheep's dung and a solution of white soap; twice more, an hour each time, with half the quantity of soap; and a fourth time in a ley of pot or pearl-ashes, one pound to twenty of yarn, another hour. He then passes it through iron liquor, to every gallon of which half a pound of red chalk, or ruddle, in powder, is added; the liquor being poured off clear, after it has stood four hours to settle; and immerses it in an alkaline lixivium. When of the proper colour, for which this operation may be repeated if necessary, he dries it, as after each of the former processes; and then puts it into a warm lixivium, in which it is brought to a scald. It is afterward to be soaked an hour in water made almost as sour as lemon juice with sulphuric acid, and then washed and wrung twice. Lastly, it is to be boiled slowly an hour in a solution of white soap, one pound to ten of yarn.

The ancients appear to have had the art of preparing a blue enamel from iron. M. Klaproth analysed a piece of antique glass of a sapphire blue colour, transparent only on the edges, two hundred grains of which gave the following products: silex 163 grains; oxide of iron 19; alumina 3; oxide of copper 1; lime 0.5. The loss was 13.5.

Iron is very liable to be oxided, or contract rust. Conté informs us, that if fat oil varnish be mixed with half, or at most four-fifths of its weight of oil of turpentine, and this be applied lightly and evenly with a sponge to iron or steel, and left to dry where it is not exposed to dust, the metal will retain its lustre, without any danger of rusting. In order to prevent gun-barrels from rusting they are frequently browned. This is done by rubbing it over, when finished, with aquafortis, or spirit of salt diluted with water, and laying it by for a week or two till a complete coat of rust is formed. A little oil is then applied, and the surface, being rubbed dry, is polished by means of a hard brush and a little bees-wax.

The yellow spots, called iron moulds, which are frequently occasioned by washing ink spots with soap, may in general be removed by lemon juice, or the oxalic or tartarous acids; or by muriatic acid diluted with five or six parts of water, but this must be washed off in a minute or two. Ink spots may readily be removed by the same means. If the iron mould have remained so long, that the iron is very highly oxided, so as to be insoluble in the acid, a solution of an alkaline sulphuret may be applied, and, after this has been well washed off, the acid will remove the stain.

IRON-FOUNDRY, the art of casting iron, and forming moulds, into which it is poured when in a fluid state.

The moulds are commonly made in sand, held in wooden frames, (fig. 3 and 4, Plate Iron-foundry.) Two of these frames, A B, (fig. 4.) are called a pair of flasks, and fit together by pins, *a a*, in one flask, entering eyes, *b b*, in the other. A wooden pattern of whatever is to be cast must first be made, exactly of the same dimensions as the article required. For an example, we have chosen to describe the manner of casting a roller, such as is used for the wheels of small waggons, the rolls of windmill heads, &c. The pattern is shown in fig. 5, 6, and 7: fig. 5 is a plan, fig. 6 a section, and in fig. 7 it is shewn edgeways. This pattern is exactly similar to the wheel which is to be cast, except that in place of the hole through the centre of the wheel: a pin, *m*, is stuck on, projecting from each side in the same place that the holes will be: the use of these pins will be shown hereafter. The lower flask, A, (fig. 4.) is placed on a board laid on the ground: it is then filled with sand, and rammed down, first with the rammer, (fig. 9) and afterwards with fig. 10, which is broader, and smooths the work. The workman then with the trowel, (fig. 8) digs out a hole in the sand, and presses the pattern into it, the flat surface horizontal, and fills the sand in round the pattern, until it is exactly half buried, he then takes out the pattern, and if there are any holes in the under part, where the sand is not filled round close to the pattern, he puts in a small quantity of sand, and presses the pattern down again, until a perfect impression of it is left in the sand, as in fig. 1. He now returns the pattern, and sprinkles some dry sand, which has been burnt in the furnace, over the pattern and flask, and then places the upper flask, B, (fig. 4) upon it: two small sticks are placed upon the pattern, and the sand filled in round them; the sand is rammed down by the rammers (fig. 9 and 10), and the two sticks drawn out, leaving holes, *l l*, (fig. 2) through the sand in the upper flask. The workman now takes off the upper flask, B, by its two handles, leaving the pattern in the lower flask; the burnt sand causes the two flasks to separate exactly at the joining of the flasks: the upper flask is now completely finished, the holes, *l l*, made by drawing out the sticks, being left to pour in the metal, and the pattern leaving a perfect print of

its upper half in the flask. The next operation is lifting the pattern out of the lower flask, before which the workman wets the sand around the pattern, that it may adhere together, and not be broken by lifting the pattern. The two pins projecting from the wheel where the hole is to be, leave their impressions in the sand, forming two holes. *e f* (fig. 2) one in each flask. These holes receive the ends of a core, which is exactly the shape and size of the hole required in the wheel: the core is formed of a mixture of plaster of Paris and brick-dust, and is made just the length and size of the pins in the pattern, that it may be truly in the centre of the wheel. Fig. 2. is a section of the two flasks when put together; but the core is not put in: *l l* are the holes for the metal, and *g h i k* the hollow cavity to receive it.

The iron is melted in a furnace, and brought from it in a ladle (fig. 11) which has three handles, and is carried by two men, the forked handle, M, giving a purchase to the man holding it, to turn over the ladle to deliver its contents. If the work is very small, the metal is conveyed to the flasks in common ladles.

The more intricate cases of iron-foundry, as the casting of cylinders for steam engines, crooked pipes with various passages, &c. are cast in moulds formed of loam or clay, and are done nearly in the same manner as the moulding of plaster cast from busts, &c. but our limits will not allow us to describe these curious branches of the founder's art.

IRONY, in rhetoric, is when a person speaks contrary to his thoughts, in order to add force to his discourse.

IRRATIONAL, an appellation given to surd numbers and quantities. See SURD.

IRREDUCIBLE *case*, in algebra, is used for that case of cubic equations where the root, according to Cardan's rule, appears under an impossible or imaginary form, and yet is real. Thus in the equation, $x^3 - 90x - 100 = 0$, the root, according to Carden's rule, will be $x = \sqrt[3]{50 + \sqrt{-24500}} + \sqrt[3]{50 - \sqrt{-24500}}$, which is an impossible expression; and yet one root is equal to 10; and the other two roots of the equation are also real. Algebraists, for two centuries, have in vain endeavoured to resolve this case, and bring it under a real form; and the question is not less famous among them than the squaring of the circle is among geometers. See EQUATION.

It is to be observed, that as in some other cases of cubic equations, the value of the root, though rational, is found under an irrational or surd-form; because the root in this case is compounded of two equal surds with contrary signs, which destroy each other; as if $x = 5 + \sqrt{5} + 5 - \sqrt{5}$; then $x = 10$; in like manner, in the *irreducible* case, when the root is rational, there are two equal imaginary quantities, with contrary signs, joined to real quantities; so that the imaginary quantities destroy each other. Thus the expression: $\sqrt[3]{50 + \sqrt{-24500}} = 5 + \sqrt{-5}$; and $\sqrt[3]{50 - \sqrt{-24500}} = 5 - \sqrt{-5}$. But $5 + \sqrt{-5} + 5 - \sqrt{-5} = 10 = x$, the root of the proposed equation.

Dr. Wallis seems to have intended to shew, that there is no case of cubic equations irreducible, or impracticable, as he calls it, notwithstanding the common opinion to the contrary.

Thus in the equation $r^3 - 63r = 162$, where the value of the root, according to Cardan's rule, is, $r = \sqrt[3]{81 + \sqrt{-2700}} + \sqrt[3]{81 - \sqrt{-2700}}$, the doctor says, that the cubic root of $81 + \sqrt{-2700}$, may be extracted by another impossible binomial, *viz.* by $\frac{9}{2} + \frac{1}{2}\sqrt{-}$; and in the same manner, that the cubic root of $81 - \sqrt{-2700}$ may be extracted, and is equal to $\frac{9}{2} - \frac{1}{2}\sqrt{-3}$; from whence he infers, that $\frac{9}{2} + \frac{1}{2}\sqrt{-3} + \frac{9}{2} - \frac{1}{2}\sqrt{-3} = 9$, is one of the roots of the equation proposed. And this is true: but those who will consult his algebra, p. 190, 191, will find that the rule he gives is nothing but a trial, both in determining that part of the root which is without a radical sign, and that part which is within: and if the original equation had been such as to have its roots irrational, his trial would never have succeeded. Besides, it is certain, that the extracting the cube root of $81 + \sqrt{-2700}$ is of the same degree of difficulty, as the extracting the root of the original equation $r^3 - 63r = 162$; and that both require the tri-section of an angle for a perfect solution.

IRREGULAR, in grammar, such inflections of words as vary from the original rules: thus we say, irregular nouns, irregular verbs, &c.

END OF VOL. III.

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